CANADIAN ELECTRONICS ENGINEERING

SEPTEMBER 1958
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ASTOR, LENOX AND TILDEN FOUNDATIONS

Careful testing leads to new design for recording head . . . 20

What is happening to hi-fi in Canada? 23

Microwave network now spans whole country 28

New machines take closer look at atom 32

Commercial scatter conquers Canada's rugged northland . . 37

How quickly does a twin-T respond? 40

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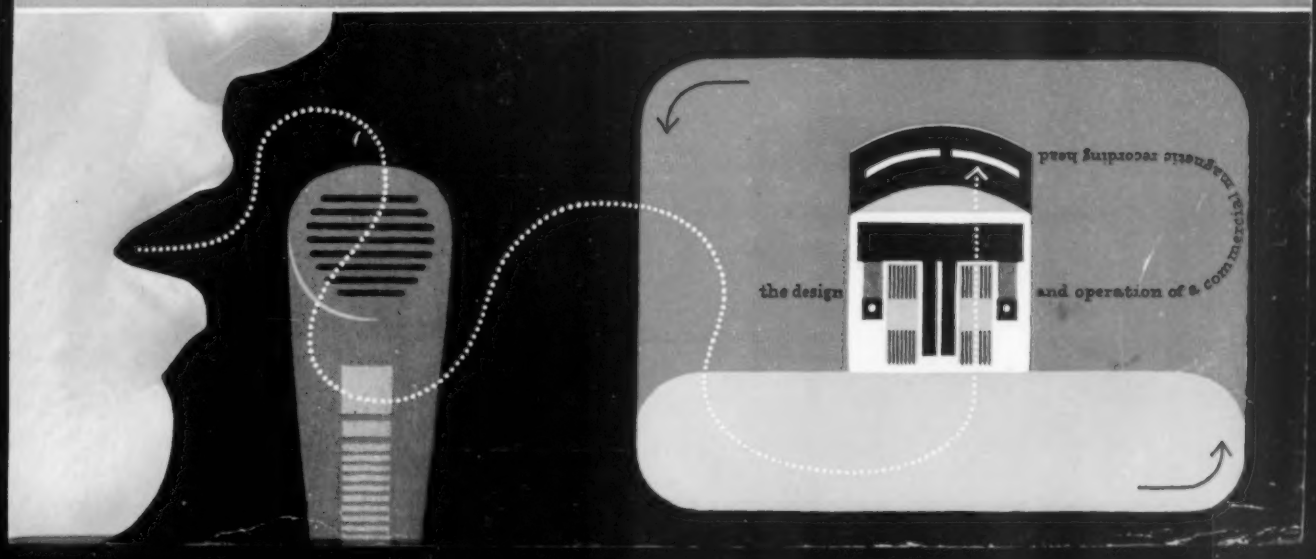
TTFH



WHILE NERO FIDDLED

One windy Tuesday in Rome during the reign of the infamous Nero, a new mobile radar unit, on its way for delivery to the emperor's legions outside the city, suddenly caught fire. A tube blew, the sparks flew, the horses bolted, and soon all Rome was ablaze.*

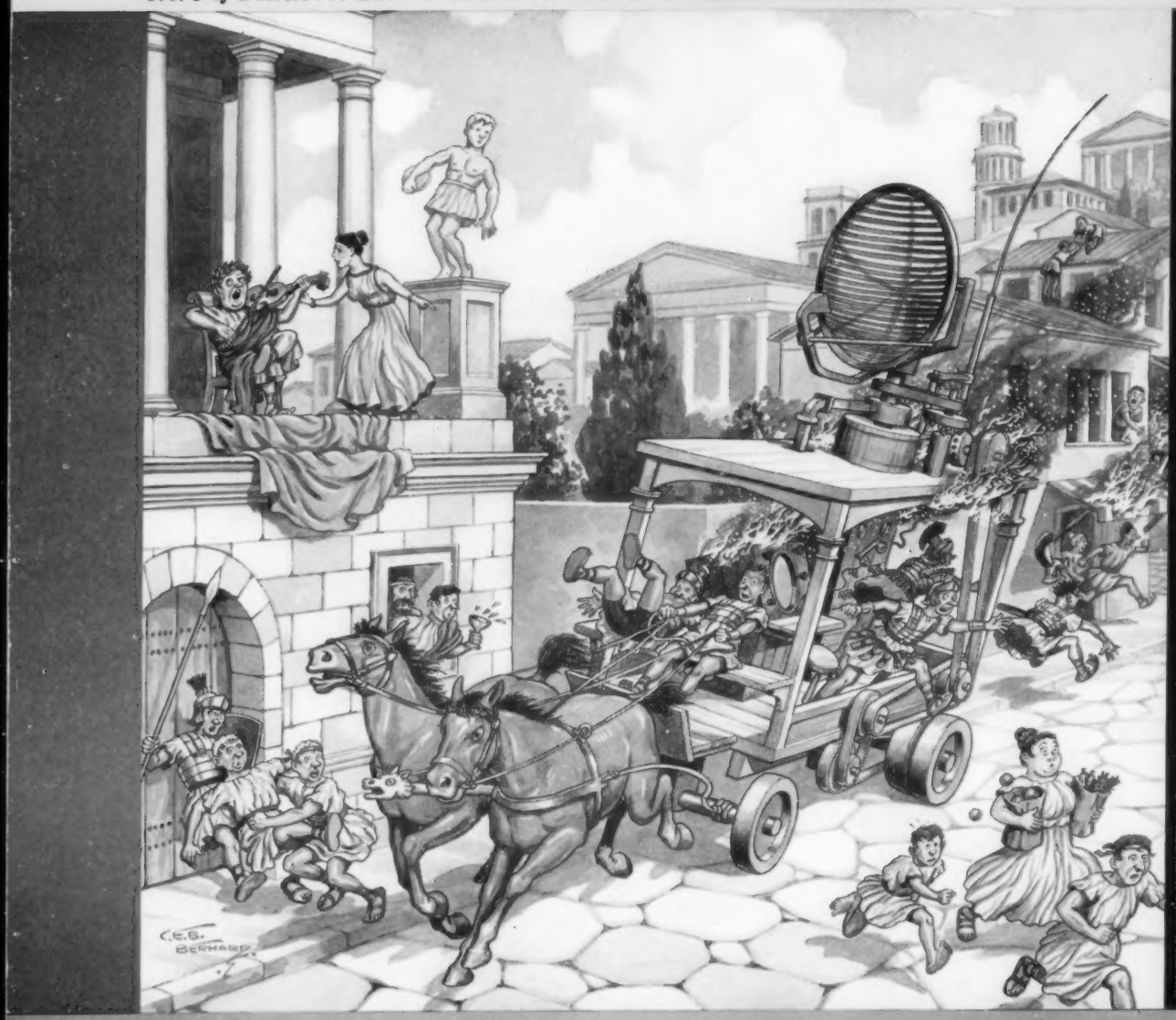
Nero was furious. He had the members of the ill fated crew brought before him. "I'll make the punishment fit the crime!" he roared. While he thought about it, he picked up his violin and began to play. Since he was the vilest of violinists, the feelings of his listeners may better be imagined than described. He scraped his way through 'Keep the Rome Fires Burning' and 'Smoke Gets in Your Eyes.' At last he paused, confronting his trembling listeners.

"I'm going to have you all boiled in oil!" he boomed.

"THANK GOODNESS!" one of the doomed wretches exclaimed fervently as they were being led away. "For a minute I thought he was going to play 'Smoke Gets in Your Eyes' again!"

The obvious moral: *It doesn't pay to go horsing around with inferior tubes.*

No. 6 of a series **... BOMAC LOOKS AT RADAR THROUGH THE AGES**



* *Bomac makes the finest microwave tubes and components this side of the Coliseum*

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September 1958

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*** our cover design** *In his third cover for CEE, artist Hans Kleefeld portrays Sonograph's new magnetic head as a vital element in the whole recording process*

The PL5557 Mercury Vapour Thyratron is one of a line of Rogers reliable industrial tubes designed and engineered to give long life and dependable service. The PL5557 is recommended for use in switching and control applications. It can be used as a direct plug-in replacement for any of the following 13 tube types: 17, FG17, TT17, MT17, 5557, GL5557, WL5557, 272, NL715, 967, CE309, 4261 and TH6011.

The PL5557 thyratron has a peak inverse rating of 5000 volts and a peak anode current of 2.0 amp. Write for full details.

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CANADIAN ELECTRONICS ENGINEERING

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Hallam

Asten

contributors and special articles in this issue:

Author of the lead article in this issue (Careful testing leads to new design for magnetic recording head), **Paul A. Hallam** is making his second contribution to the pages of CEE. In March he was a joint author of a story on a three-channel tape recorder. This month he describes further work done while he was with Sonograph Engineering and Manufacturing Company Ltd.

Mr. Hallam joined Sonograph in 1955 after graduating in electrical engineering from the University of Toronto. He is now an engineer in the flight test instrumentation department at Avro Aircraft Ltd., Malton, Ont. There his duties comprise the interpretation of flight test data, currently on the supersonic CF-105 Arrow development program.

K. J. Asten (What is happening to hi-fi in Canada?) was able to combine business with pleasure in conducting and analyzing his survey of audio purchasing habits. The survey was submitted as a term report in one of his courses at Sir George Williams College, Montreal, and its subject matter concerns his principal hobby — high fidelity audio equipment.

Born in Manchester, England, Mr. Asten came to Canada with his parents when he was five. He joined the Royal Canadian Artillery in 1939 and was overseas from 1941 to 1946, landing in Normandy on June 6, 1944 (D-Day). Since then he has held a variety of positions with Stewart-Warner-Alemite, the Civil Service, Canadian Aviation Electronics and the Bell Telephone Co.

He is presently with the Toll Area branch of Bell Telephone and has recently graduated from a general science course at Sir George Williams that has occupied his spare time for the past 3½ years. Mr. Asten still maintains his interest in the Army, being a Captain in the 4th Signal Regt., R.C.S. (Militia).

Maurice Price of Computing Devices previously held the record with three articles in CEE. Now he clinches it with his fourth (How quickly does a twin-T respond?), a short piece of circuit theory of value to designers in various fields.

When this issue is published, the second United Nations International Conference on the peaceful uses of atomic energy will be in full session at Geneva, Switzerland. Leonard Bertin, science editor of the Financial Post is attending the conference and will report in a later issue on matters of particular interest to CEE's readers.

Associate editor **Ian R. Dutton** (New machines take closer look at atom) sets the stage for Mr. Bertin's report with a world-wide review of developments in high-energy particle accelerators.

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Indexed in Engineering Index.

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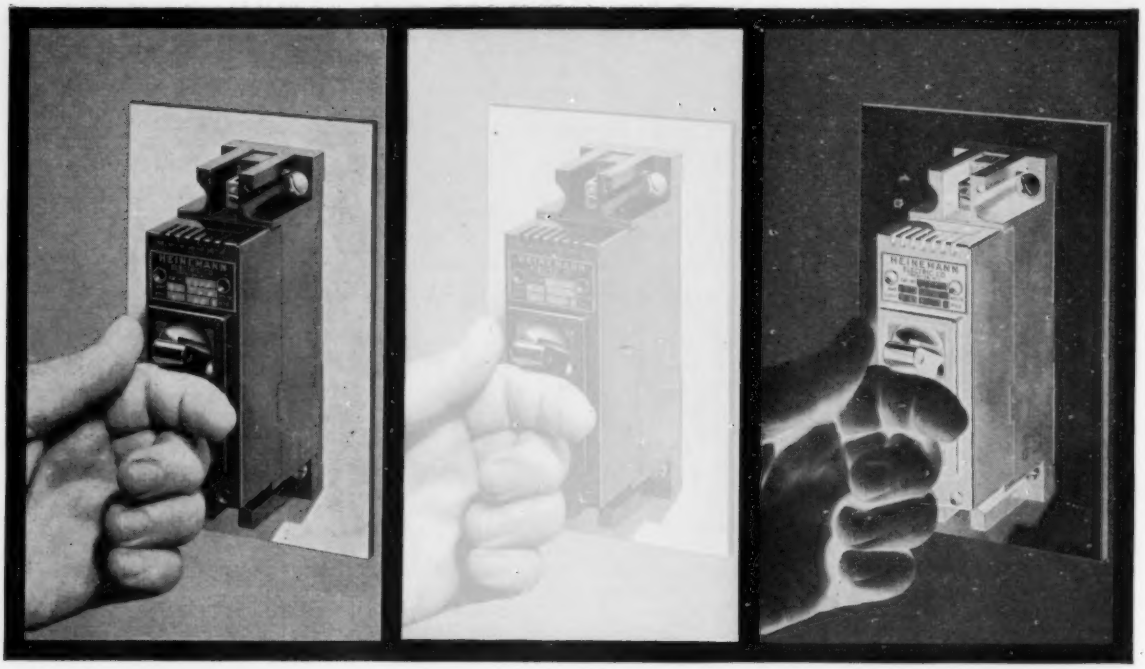
HIGH-PLUS OR LOW-MINUS TEMPERATURES

CAN'T TROUBLE HEINEMANN CIRCUIT BREAKER RATINGS



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Circuit breakers

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News highlights . . .

To the moon — and back again . . .

Collins Radio Company and the U. S. Army believe that recent tests very probably represent the first time that intelligence has been transmitted in the region of 1000 mc from the earth to the moon and back. Signal was radio-teletype message, transmission frequency 810 mc.

Television in a satellite . . .

The lunar satellite used in the unsuccessful August 17 moon rocket launching houses television's most "forward-looking" application. Scanning device has gyroscope to keep it aimed constantly at the moon — scientists hope to get pictures of the hidden side.

New Home for Astra planned . . .

Latest indicator of government intentions regarding production of CF-105 Avro Arrow interceptors was calling of tenders for $1,000,000 building at Malton, Ont. Building, to be leased to RCA Victor, will house assembly and test operations of Astra weapons control system. Occupancy is scheduled for November.

Revolution in power generation . . . ?

John Campagne, Moose Jaw, Sask., electronic technician, claims to have invented a radically new means of producing electric power on a large scale. Campagne, a Radio College of Canada graduate, says basis of his method is temperature differential between large areas of water and surrounding atmosphere.

"Weigh nothing, occupy no space . . ."

Quote of the month comes from Albert E. Cookson, director of I.T. & T. Laboratories' missile guidance section. Referring to a miniaturized tracking transmitter-receiver, he said: "As in most missile instrumentation units, it was desirable that it weigh nothing, occupy no space, draw zero power from the missile, and operate without antennas."

APEO continues steady growth . . .

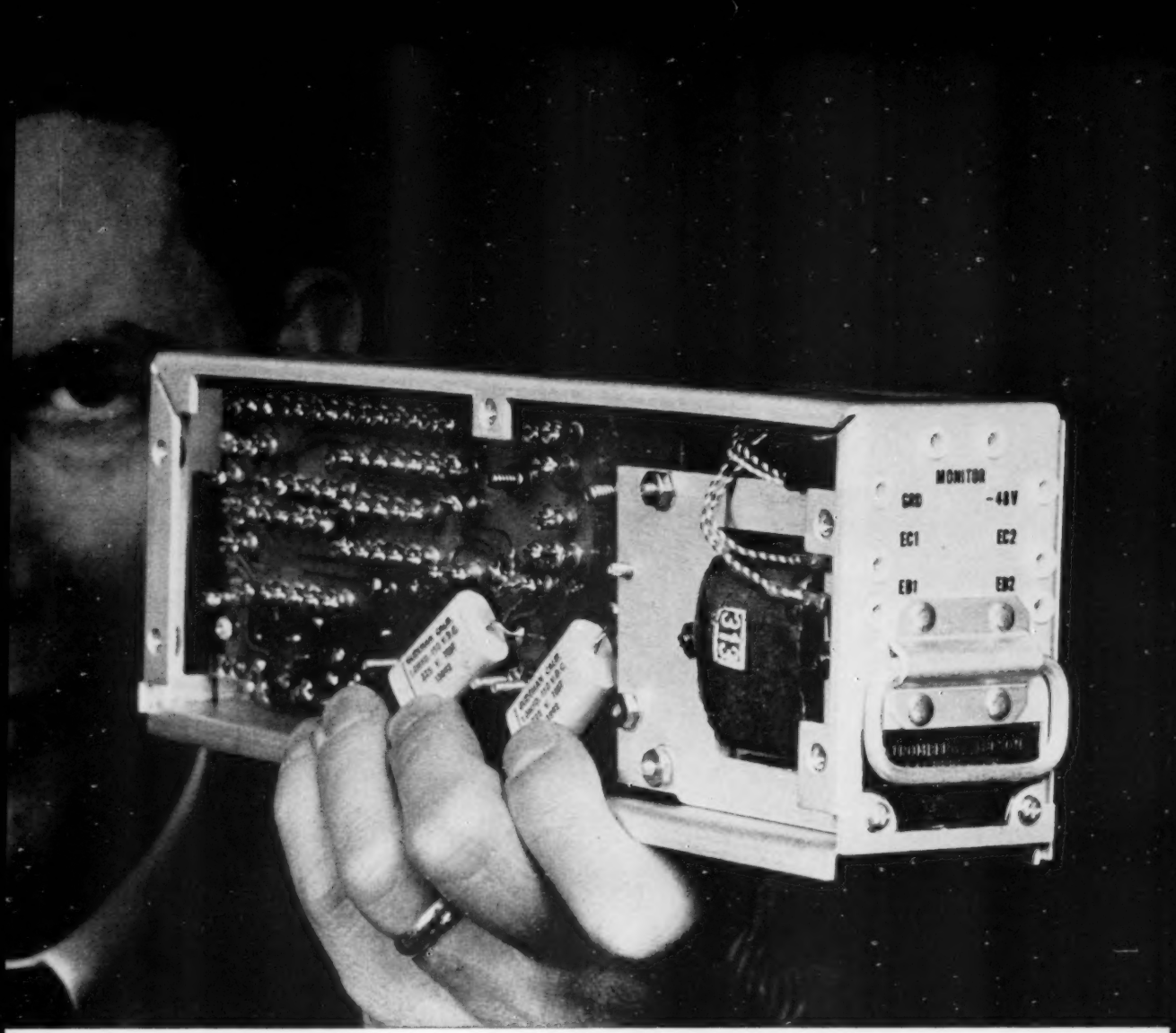
Membership in the Association of Professional Engineers of Ontario has grown to 17,500, with the registration of nearly 350 new members in July. Certification of technicians and technologists is progressing, with 528 certified out of nearly 700 applications received.

EIA: TV sales strengthening . . .

Television distributor sales to dealers were up again in June. This was the fourth consecutive month that sales have shown an increase over the corresponding months of last year. Total sales for March, April, May and June, at 97,339 units, were 5.5% ahead of those months in 1957.

R. M. Robinson, president, recently addressed the American Vocational Association on "The age of automation and its effects on electronic curricula." See comment on page 19 for further details.

The annual EIA-IRE Golf Tournament will be held September 25 at the Cedar Brae Golf and Country Club, Scarborough, Ont. An EIA Components Division meeting in the morning will be followed by golf in the afternoon, to which all members of either body are invited.



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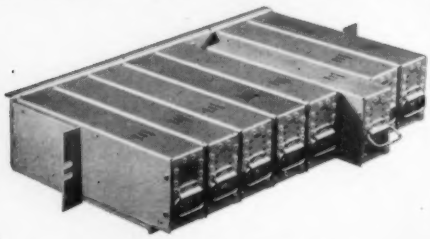

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Griffith appointed v-p Canadian Overseas Telecommunication Corp

Ronald G. Griffith, P.Eng., chief engineer of the Canadian Overseas Telecommunication Corp., has been appointed vice-president of the corporation. In making the announcement Transport Minister George Hees said that Mr. Griffith "has had much to do with the development of overseas communications throughout the world and is recognized as one of Canada's top telecommunications engineers."

Mr. Griffith who started studying telecommunications general engineering at the age of 18 joined the Canadian Overseas Telecommunications Corporation in 1954 as chief engineer. Since then he has supervised the installation of the West Coast Overseas Radio Services; the Canadian Engineering requirements for the first transAtlantic telephone cable; and the establishment of the communication centre in the new Montreal building. He has had the unique experience of having designed major communication centres in Montreal, London and New York.

Mr. Griffith is a native of London, England, born December 1, 1900. After receiving practical training in submarine cable telegraphy, while with the Royal Naval Air Service, he entered the Institute of Electrical Engineers to receive his degree in 1924.

After graduation Mr. Griffith held a number of important positions with companies doing communications work in North and South America as well as in Europe. With the approach of the Second World War he was made responsible for special communication emergency provision in the London area until 1943, when he was seconded to the British Foreign Office. He was appointed chief engineer of the Inter-Services Cypher Policy Board supervising the development of a machine cypher telegraph system, which was used in the latter stages of the war and still on the secret list.

In 1951 he came to Canada and joined Radio Engineering Products Ltd., Montreal, as director of Mechanical Development. In two years Mr. Griffith produced the first teleprinter to be developed in Canada and during his career so far has obtained a large number of patents mostly relating to telecommunications.

Gerald Edward Martin, C.A., F.C.I.S., has been appointed director of the Canadian Overseas Telecommunication Corporation for a term of three years. Mr. Martin, a prominent resident of Halifax, is a senior partner of the firm Lea & Martin.

Mr. Martin, a native of Southborough, Kent, England, served with the Royal Navy in World War I. He has seen telecommunication service with the Pacific Cable Board in the Australian and West Indian Systems.

Mr. Martin takes over a directorship left vacant on retirement from the board, of R. M. Brophy, Toronto, who was one of the original directors at the time the Crown company came into being in 1950.

Griffith

Barker

Engineer moves up at Standard Telephones & Cables

H. James Barker has been appointed executive vice-president and a director of Standard Telephones and Cables Manufacturing Co. (Canada) Ltd. Mr. Barker has served the Canadian company in the capacity of chief engineer for over four years and prior to this, served for 16 years in various assignments for the Transmission Division of Standard Telephones & Cables Ltd., London, England.

Both companies are associates of International Telephone & Telegraph Corporation.

Pioneer of radio closes his shop

Dr. Lee de Forest has closed his laboratory after nearly 60 years of research and invention.

For the last seven years the United Manufacturing Co. of Chicago has been sponsoring research at the laboratory. They have been searching for a means of converting heat directly into electricity. The manufacturer has decided to discontinue the project.

"I found several solutions," he said, "but they were too inefficient and we have decided to give up further research into it. I had to close the laboratory."

Before closing the laboratory de Forest, who holds more than 300 patents, filed patent papers on an invention for a new color television receiving tube.

New export manager for E.M.I.

E.M.I. Electronics Ltd., announce the appointment of **Mr. K. Elphinstone, M.B.E.,** as export manager. E.M.I. is at present engaged in an all-out drive to increase sales of its electronic equipment overseas and Mr. Elphinstone will be responsible for the company's activities in that field. He takes up this post following Mr. R. W. Addie's recent appointment to the board as marketing director.

Air Vice Marshall Godwin joins RCA Victor

Upon his retirement from the Royal Canadian Air Force, **Air Vice-Marshal H. B. Godwin** joined RCA Victor Company Ltd. in an executive capacity as a vice-president and an officer of the company.

Godwin

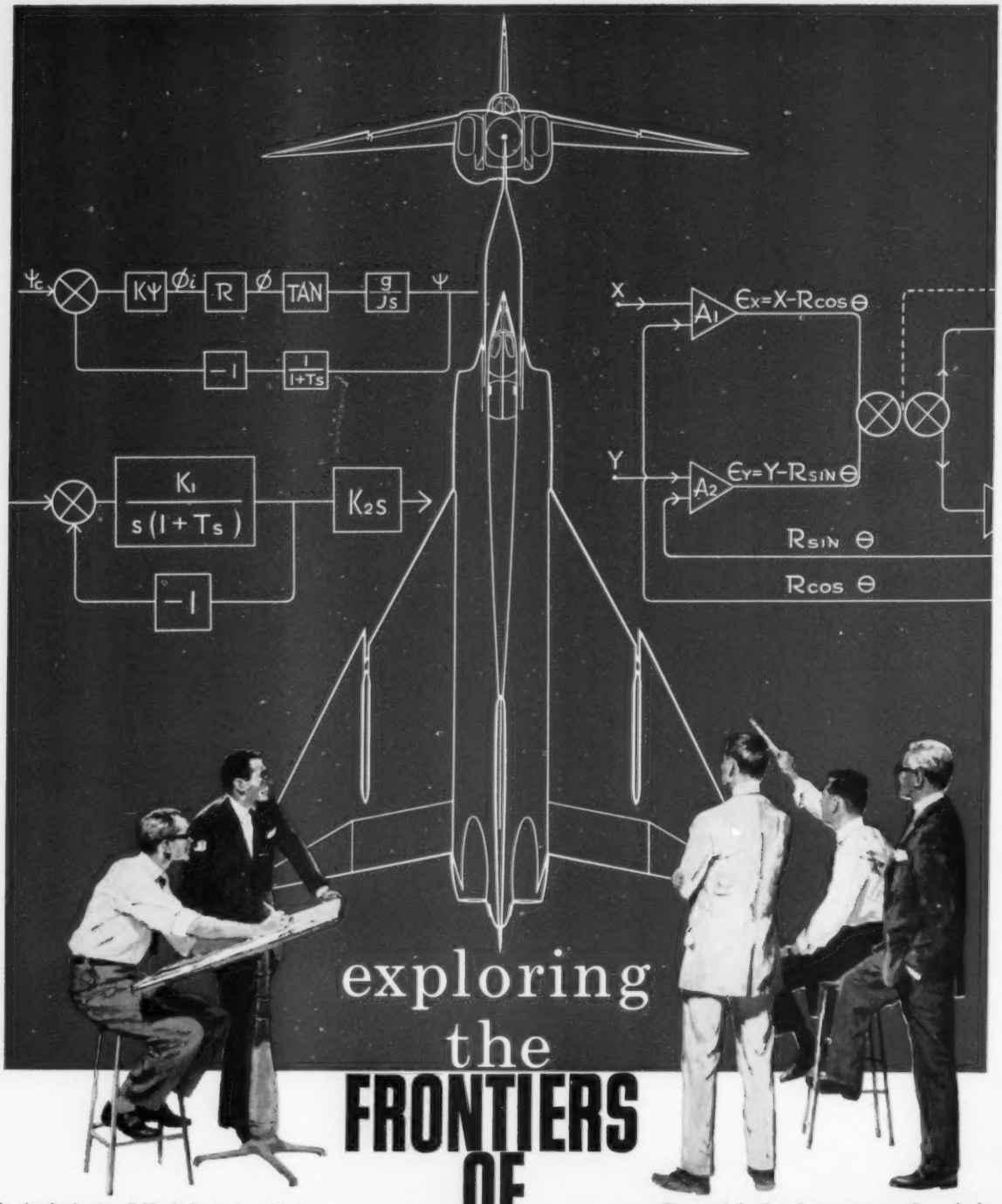
A native of Westmount, Que., Air Vice-Marshal Godwin graduated from McGill University in 1928 as an electrical engineer. That year he joined the RCAF and majored in telecommunication work. During the war his services were chiefly confined to command and staff assignments in the three fields of telecommunications, training and operations.

Air Vice Marshall Godwin was transferred overseas in April 1945, then returned to Canada in 1947 to become Deputy Air Member for Air Plans at Air Force Headquarters.

In January 1952 he was named Air Officer Commanding, Air Materiel Command, a position he held until appointed Commander of RCAF No. 1 Air Division in August, 1955.

McArthur promoted at Canadian Westinghouse Company

A. A. McArthur, has been appointed manager, Apparatus Sales for the Canadian Westinghouse Co. Ltd. Mr. McArthur, who joined Westinghouse in 1936 as an engineering student from the University of Toronto, will be responsible for the operations of the company's utility, industrial, aviation, marine and transportation sales departments. He will also provide assistance to the vice-president in charge of Apparatus and Industrial Sales in the commercial activities associated with the development of these markets.



exploring the FRONTIERS OF TOMORROW

In the fascinating field of electronics – it's tomorrow that counts. The drawing boards of RCA Victor engineers reflect tomorrow's advances in Defence Electronic Systems technology.
One example of their work: the integrated electronic system to be used in Canada's first supersonic plane—the Avro Arrow.

The search for the talent so necessary for work of this nature will never end. Perhaps you – or someone you know – is an engineer who would like to work with RCA Victor – and meet its creative challenges in this stimulating field. If so, simply contact Dr. J. J. Brown, RCA Victor Company, Ltd., 1001 Lenoir Street, Montreal, Quebec.

DEFENCE ELECTRONIC SYSTEMS

RCA VICTOR COMPANY, LTD.

MONTREAL

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CGE awarded $3.5 million defense contract for radar sets

The largest single unclassified contract awarded by the Department of Defence Production in recent weeks went to Canadian General Electric Co. Ltd. Valued at $3,488,479, it covers the supply of an undisclosed number of height-finding radar sets. These will be used to supplement Canada's existing radar network, particularly on the Pinetree line.

A company official stated that extensive modifications to the design of earlier equipment would be incorporated in the new sets. They will be manufactured at CGE's Royce Works plant in Toronto, where, it is estimated, about 100 new job openings will be created.

Other DDP contracts

Unclassified electronics contracts for $10,000 or more were also awarded to: Adams Engineering Ltd., tubes, $18,625; Alpha Aracon Radio Co. Ltd., capacitors, $10,839, equipment, $11,936, and tubes, $14,316; Ampex American Corp., equipment, $55,530 and $13,723; Automatic Electric Sales (Canada) Ltd., components, $18,490; Canadian Applied Research Ltd., technical publications, $11,920, electronic equipment, $74,213 and aircraft navigational equipment, $30,913 and $90,000; Cdn. Arsenals Ltd., field mod. kits for radar sets, $18,030; Cdn. Aviation Electronics Ltd., repair and overhaul of electronic materiel and simulators, $4,004,118 (total of four contracts); Cdn. Charts & Supplies Ltd., equipment, $237,746; Cdn. General Electric Co. Ltd., tubes, $15,288; Cdn. Line Materials Ltd., equipment, $10,565; Cdn. Marconi Co., equipment $19,920 and $13,866; Cdn. National Telegraphs, cable extension, $32,000; Cdn. Pacific Railway Co., maintenance of teletype equipment, $50,000; Collins Radio Co. of Canada Ltd., equipment, $228,094; Computing Devices of Canada Ltd., ground electronic materiel, $627,280.

Domac Technical Sales Ltd., test equipment, $19,307; Electronic Materiels International Ltd., repair and overhaul of aeronautical electronic equipment, $10,000; Garrett Mfg. Corp. of Canada Ltd., repair and overhaul of electronic materiel, $139,500; Honeywell Controls Ltd., repair and overhaul of electronic materiel, $260,000, and technical publications, $31,121; Marsland Engrg. Ltd., equipment, $17,708; NSL Electronics (Canada) Ltd., technical services, six contracts for $15,538 each; Ontario Hydro, testing of equipment, $255,000; RCA Victor Co. Ltd., research, $34,631, and equipment, $517,372; Rogers Majestic Ltd., radios, $12,154; Sinclair Radio Labs. Ltd., equipment mods., $20,282; Titania Electric Corp. of Canada Ltd., equipment, $10,500.

Sharpe sells magnetometers to Chinese Republic

Sharpe Instruments Ltd., of Willowdale, Ont., have scored an unusual success in selling $50,000 worth of geophysical instruments to the Chinese People's Republic. Despite the fact that their bid was the highest, the Canadian firm won the contract against direct competition from suppliers in Britain, Germany, Sweden, France and Russia. Further contracts for up to $500,000 may follow.

Explorer III to be shown at IRE Convention

The Canadian Astronautical Society have arranged for a special exhibit at the IRE Canadian Convention and Exposition, October 8, 9 and 10.

It will feature an earth satellite identical to the Explorer III that is now in orbit. The walk-around display will include the 6-in. diameter, 7-ft-long satellite and a series of panels describing the Jupiter C project, of which the Explorer is a part. It will be manned by two members of the U. S. Army. Arrangements for its appearance were made with the co-operation of Gen. Arthur Trudeau, U. S. Army R & D chief.

CAS will show in their own booth a full-scale model of their two-stage high-altitude research rocket, together with thrust measuring rigs, fuel loading tools, and rocket components including a fiberglas shell and telemetry equipment.

Company news briefs

Hudson Randall International, Toronto, now market in Canada the products of U. S. Gear Corp., Wakefield, Mass., including precision gears and servo gearheads.

Canadian production of Bourns Laboratories' line of lead-screw type potentiometers (Trimpots and Trimits) will begin this month at the Toronto plant of Douglas Randall (Canada) Ltd.

Valcor Engineering Corp. has appointed J. B. Morrison Machinery Co. Ltd., Toronto, as exclusive Canadian representative for their complete range of industrial solenoid valves.

Sylvania Electric (Canada) Ltd. has taken over a new 60,000 square foot distribution centre in Toronto. Others are shortly to be established in Winnipeg, Calgary and Vancouver.

C. E. Knechtel, 2285 View Lynn Drive, North Vancouver, B.C., is the new western technical representative for Bakelite Co., Division of Union Carbide Canada Ltd.

Redmond Motors of Canada Ltd., St. Thomas, Ont., has been acquired by Controls Corp. of America. The company name has been changed to Redmond Electric Motors of Canada Ltd. and new directors and officers have been elected.

"Television—Your Window on the World"

H. Warren Blahout, promotion supervisor of CFPL-TV, London, right, wins a 17-inch Sylvania portable for his Television Week slogan. Also shown are Reo Thomoson, left, chairman of TV Week committee, and Karl Steeves, TV div. manager of the Bureau of Broadcasting Advertising.

Television Week in Canada will be celebrated from September 28 to October 4

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This is the statement by the man who heads up the Toronto Chapter of the National Industrial Advertisers Association. He added, in his role as Manager Advertising and Sales Promotion, Canadian General Electric Motor and Control Department, "I believe business papers are an important influence on purchasing in most industries including our own".

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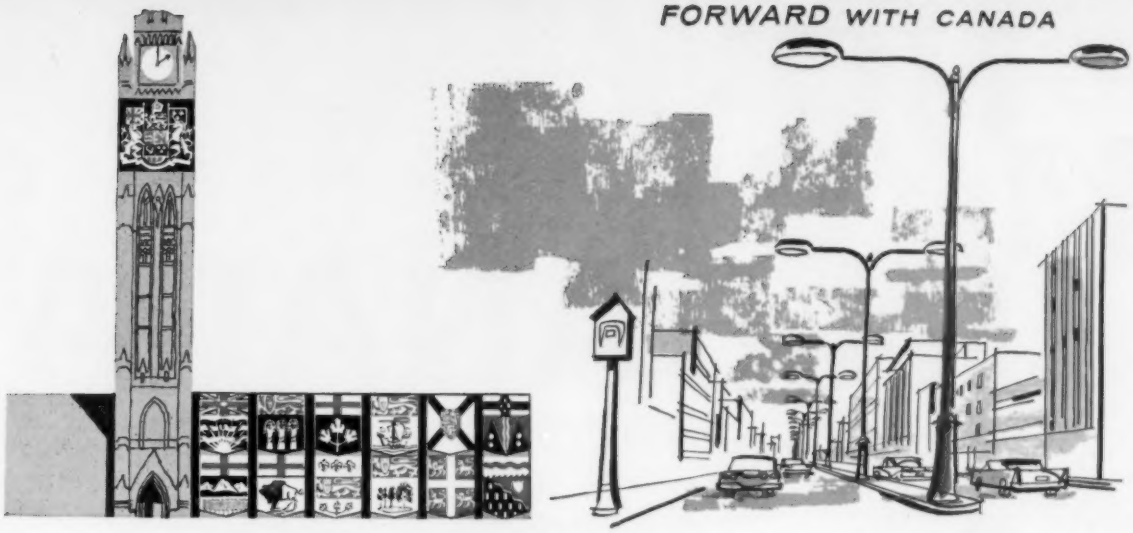
FORWARD WITH CANADA



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"You'll find them at the intersection of 'Eleventh and Elm' in any of a thousand little towns . . . or strung across the concrete canyons of a hundred hustling cities.

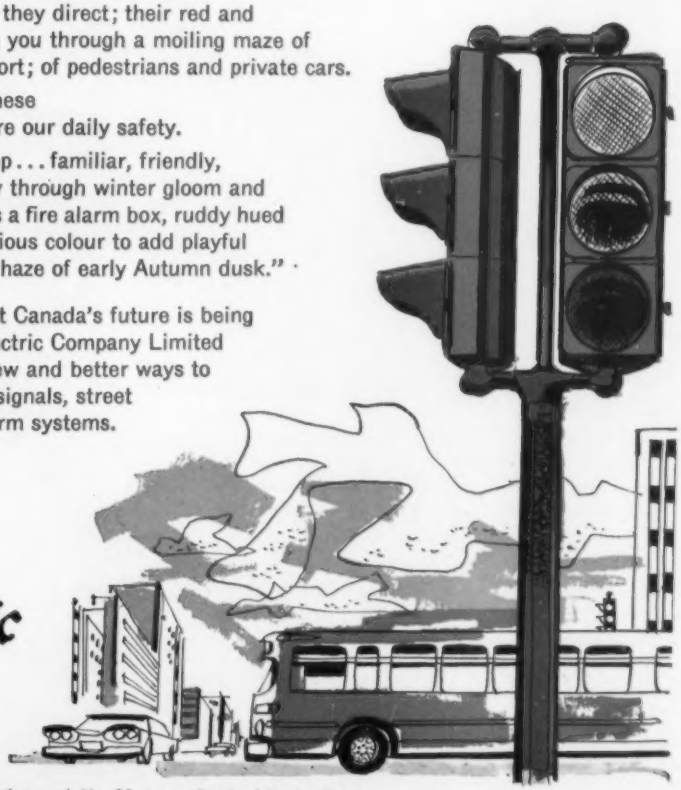
You'll find them sharing the sedate seclusion of a small suburban sidestreet . . . or standing, shadowed by a towering tenement, a movie theatre, a school, a hardware store . . .

You'll stop—or go—or wait, as they direct; their red and green and amber eyes gentling you through a moiling maze of taxis, trucks, and public transport; of pedestrians and private cars.

Their shapes may vary, too—these automated sentries which secure our daily safety.

You'll see them as a street lamp . . . familiar, friendly, comforting . . . guiding your way through winter gloom and fragrant summer night . . . or as a fire alarm box, ruddy hued and cheerful . . . a patch of precious colour to add playful contrast to the graying, wistful haze of early Autumn dusk."

In keeping with their belief that Canada's future is being shaped today, the Northern Electric Company Limited is continuously searching for new and better ways to bring you more efficient traffic signals, street lighting equipment, and fire alarm systems.



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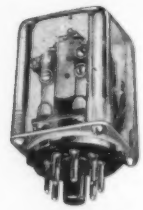

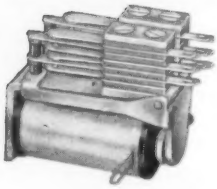

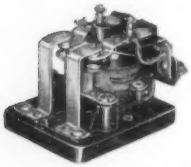

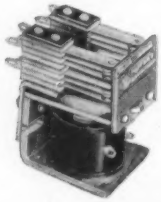

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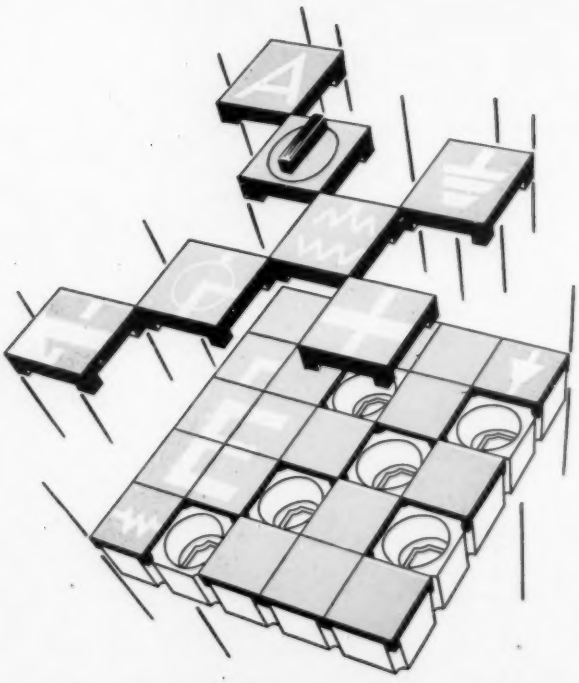

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Robinson discusses vocational education

Ronald M. Robinson, president of the Electronic Industries Association of Canada and a vice-president of Canadian General Electric Company Ltd., recently made some very telling points in an address to the American Vocational Association. We believe that they will be of great interest to our readers and present the relevant extracts below.

The industrial world of today and of tomorrow is going to require increasingly a basic knowledge of mathematics and the physical sciences. It is true that these courses are somewhat more difficult and intellectually demanding than the subjects usually found on the curricula of our nation's technical schools. But it must surely be apparent that the growing complexities of our world are indeed a formidable obstacle to the graduates of today who have not had a thorough grounding in these subjects. They will master the difficulties that face them only if they are faced with comparable difficulties while in our schools. The engineering technician of the future will require increasingly high secondary school standing.

Graduate electronic, electrical, mechanical and chemical technicians are in great demand in many branches of industry. In fact, one of the most vital figures in industry today is the engineering technician who has a sound grasp of basic theory and practice. Experience has shown that many graduates of secondary technical schools lack sufficient basic theory to be able to grasp the specialized knowledge that is becoming more and more necessary for graduates to obtain suitable employment in industry. The vocational schools should teach more basic theory so that their graduates could then go on to specialize in a branch such as industrial electronics with the necessary grounding in physics, English, mathematics and related courses.

I know that I am probably asking a great deal when I say that your curricula should be kept modern and up-to-date. Much of the new knowledge in both technological and social fields emanates from the research activities of the business world. Teachers should constantly communicate with industry and the makers of automation equipment to help keep up with the latest developments in the various technical fields that are developing so rapidly.

There is also a responsibility upon business and industry to see to it that teachers of technical courses are kept abreast of developments so that they in turn can pass along the knowledge to their students.

THE EDITOR

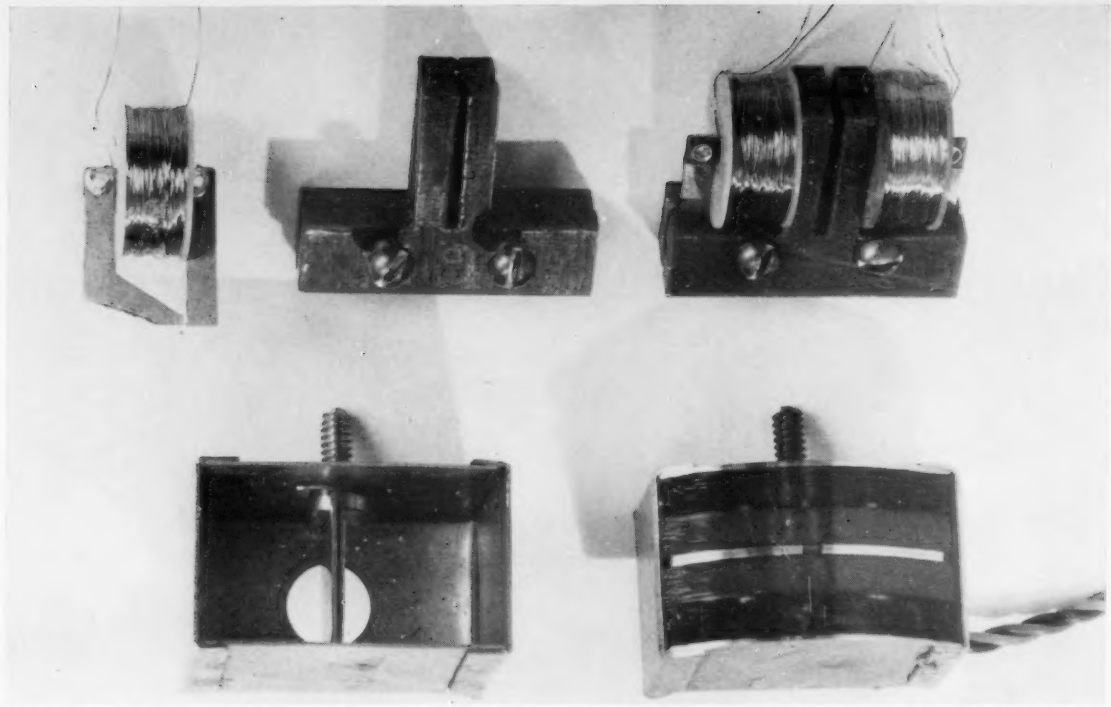


Fig. 1. This group photograph shows a completed recording head (upper left), the shielding (upper right), the inner head assembly, the clamp and one of the head elements after the coil has been mounted and the slot cut

Careful testing leads to new design for magnetic recording head

P. A. HALLAM, P. ENG.*

A recording head was needed to fulfil a number of special requirements peculiar to operation in a modern office dictating machine. As production quantities were proposed, some previously accepted principles were challenged in an effort to improve operation and reduce cost

The recording head shown in Fig. 1 was designed for use in the transistorized office dictation machine illustrated in Fig. 2. The head had to be suitable for playing back as well as recording, and it had to include an erase element in the same package.

The design was aggravated by the small space available, the narrow track width and the slow head-to-belt speed allotted by the mechanics of the system.

The recording medium

A new approach to dictation was used employing a magnetic belt suitable for mailing in a standard letter envelope. Its characteristics are the same as that of a standard quarter inch tape. It is evident that there is a limited area on which to record. Having set the record time, track width and the helical track spacing, the tape speed came out to be 2.45 inches per second. As this belt would not be compatible with tape machines the speed did not have to conform to any standard.

The record element

The record element (Fig. 3) must contain adequate iron to prevent saturation during recording, but the gap faces must not be so wide as to produce flux shunting on playback. Therefore the record-playback element is a compromise.

To achieve reasonable playback frequency response the record element gap was made as small as possible within construction limits. The gap material used was one quarter mil platinum. It is important to note that a finite gap must exist or playback sensitivity will suffer.

The material chosen for the magnetic circuit was dry hydrogen annealed mumetal for high sensitivity and maximum signal to noise ratio on playback. A track width of only 14 mils was allotted. As no pressure pad could be used, a well contoured head face was essential to insure good head-to-belt contact.

Since production of this head in quantity was important a study on component handling was made. The result of bending or swaging the annealed numetal head was dis-

*Formerly with Sonograph Engrg. & Mfg Co. Ltd., Toronto

astrous to its operation. Maltreating one head in this way caused a decrease in output of 10 db. It is important to note there was no visible deformation of the metal.

Magnetized playback head creates problems

Occasionally heads get magnetized due to switching transients, proximity of polarized magnetic fields, being dropped or being biased by an unsymmetrical wave during the recording process. It is an accepted fact that magnetizing a playback head is detrimental, but there was no available figure to say how detrimental. Magnetizing this recording head produced a decrease in signal-to-noise ratio of 10 db, an increase in distortion of five times and a decrease in output of 4 db. Thus the dictating machine had to be specially designed to avoid these problems.

Laminations reduce losses

As the bias is relatively high frequency (24 kc) the question of the effectiveness of laminating the head arose. Since the track width is only 14 mils it would be reasonable to use only one lamination. A comparison was made of a head with two 7-mil laminations versus a head with a single 14-mil lamination. The test showed that for the same amount of playback distortion the single-laminated head required 2.4 times the bias. This meant that the bias in the single-laminated head was being dissipated in core losses. Since the oscillator had to maintain a good waveshape and start easily, the heavier loading was to be avoided. Thus the extra assembly effort of two laminations was accepted.

The erase element

The purpose of the erase element (Fig. 4) is to erase only the track immediately preceding the recording head element. As there are many parallel adjacent tracks 14 mils wide, separated by a 7-mil unrecorded area, it is important that the fringe flux from the erase head stay within the boundaries of one track.

In a commercial dictating machine it is often necessary to correct a word or sentence such as a quoted date, etc. This means that the operator must, on listening to a cue, be able to instantly put the machine into "record" and simultaneously erase the error and apply the correction. This must occur without over-recording any of the other message.

Fig. 2. The new Sonograph Mark V transistorized dictating machine for which the recording head was designed

It is evident that it would be desirable to have the erase and record elements superimposed. This is mechanically and magnetically impossible. However, a calculation showed that the gaps of the two elements could be separated by 0.25 inch without losing more than the last letter of a word preceding the correction. Tests proved that an operator could easily accustom himself to "over-record" accurately without losing any of the desired message.

The erase element gap width is 7 mils. This allows the flux to spew well into the recording medium and makes the element mechanically easy to construct. Since the erase element coil is on axis with the record element coil, and the erase element carries high intensity fields, the two elements had to be shielded to prevent over-biasing the record element.

Biasing the record element

If the correct amount of cutting flux could have been arranged to bias the record element and also be strong enough to erase, no direct connections would be needed for biasing. Experiments proved that for reliable results,

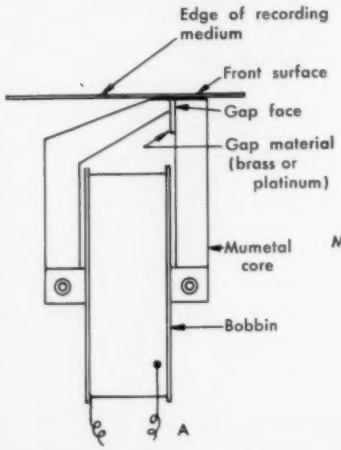


Fig. 3A. Plan view of a magnetic recording head element

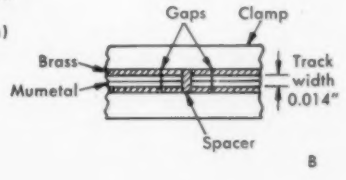


Fig. 3B. Front view of the assembly showing the relation of two elements

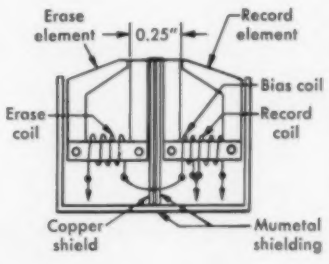


Fig. 4. Layout and connections of head elements in an assembly

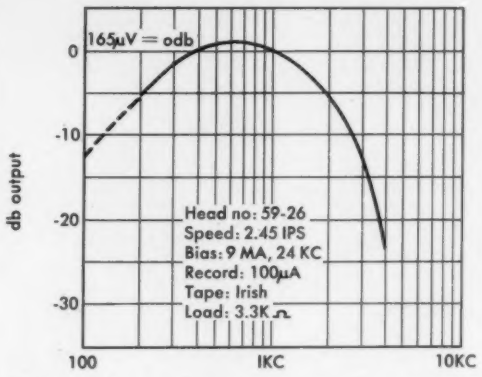


Fig. 5. The over-all frequency response curve of a typical production type record/erase/playback head

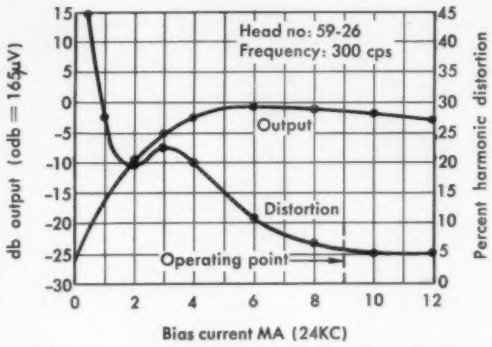


Fig. 6. Curves of output and distortion versus bias current for a magnetic recording head

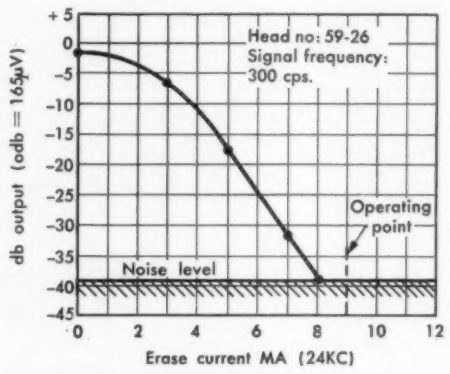


Fig. 7. Curve of output versus erase current showing attenuation of pre-recorded 300 cycle signal

it was necessary to isolate each head element by two shields. One is copper and the other mumetal. These give 40 db isolation. The bias is injected through a bias winding on the record element wired in series with the erase coil. This results in controlled bias at just the right current to give the required erasure. It also obviates the need for any external biasing circuitry from the oscillator.

By connecting the bias and erase elements in series and coupling them to the oscillator through a tuning condenser, the oscillator can be shut off remotely by removal of its supply voltage. Negligible loading occurs to the record element during playback due to the presence of this extra circuitry.

Operation of the complete recording head

Fig. 5 shows an over-all frequency response curve of a typical production type head. The zero db point on the curve refers to 165 microvolts across a 3300 ohm load resistor. This corresponds to a power of 8.3 microwatts which must be amplified by the transistors to drive a loud speaker. The high frequency response could be improved somewhat by decreasing the high frequency bias used during record but only at the expense of the distortion. Decreasing the loading on the head would also improve the high frequency response, but only at the expense of power match into the amplifier and signal-to-noise ratio.

While at first the attenuation of the highs may seem alarming it is not so serious in the application of the dictating machine. By discretely selecting a microphone element with a 3 kc peaking response and tuning the head to 3 kc on playback the system response curve becomes adequately flat. The frequency response of 300 to 3,000 cycles has been found to be ample for the reproduction of intelligence. A limited band width actually is of some advantage over a wide range one when used in noisy surroundings.

Fig. 6 shows the effect of bias on output and distortion at 300 cps. The correct amount of bias must be injected into the record element to produce high output and low distortion. Unfortunately, in magnetic recording, the parameters of bias, distortion and frequency response, work in pairs to the detriment of the third. Thus a compromise.

The criterion was to select a maximum tolerable 300 cps distortion without losing too much of the 3 kc signal. The chosen operating point was 9 ma giving 5.5% distortion at 300 cps. The distortion at 300 cps was considered very important since the third harmonic lies right in the middle of the pass band. The bias required to assure this maximum distortion level is more than enough to produce a good output at 300 cps. The discontinuity in the distortion curve is probably due to the change of slope in the recording medium's hysteresis curve at low bias levels.

Fig. 7 shows the effect of erase current in the erase element on a prerecorded 300 cycle signal. It can be seen that the operating point of erase current is the same as that of bias current in Fig. 6 since the two elements are in series.

This dictating machine has a bulk-erase permanent magnet as well as the ac erase provided in the head. The ac erase is useful however not only for making corrections but for assuring the recording element of a neutralized tape prior to recording. The result is a better playback signal-to-noise ratio. In this case the improvement was around 7 db.

It has been the object of this paper to give some practical values to a subject which tends to be too general from an engineering design point of view. With the increasing interest in magnetic recording both from a commercial and military viewpoint it is hoped that some of the results and conclusions will be applicable elsewhere. END

A survey was made among forty-six owners of true high fidelity equipment. Questions were asked regarding the types of equipment owned, country of manufacture, record and music preferences, opinions on price and future trends, and personal history of the owner

A well planned hi-fi set can complement any room as well as provide many hours of fine entertainment for discriminating listeners. This photo is one of the series that illustrated the interesting article on hi-fi in the March issue of Canadian Homes and Gardens.

What is happening to hi-fi in Canada?

K. J. ASTEN*

High Fidelity systems in their present form have been available to the general public only since the end of World War II, although some engineers and technicians (usually connected with the broadcast industry) attempted to improve the sound section of ordinary AM radios, and in some cases used studio transcriptions in home record systems. It is doubtful whether the movement would have reached its present proportions without the impetus of the high fidelity, long-playing record, and the advent of frequency modulation broadcasting.[2]

It was early in 1948 when Columbia records sold the first LP records using the microgroove technique. At first the frequency range was not great (the writer has several of this type), but due to competition and a ready market it is now possible for the frequency range to exceed the capability of the pickup and the ear. (120-25,000 cycles is now recordable but not easily replayed above 15,000 cycles.)[4]

The growth of hi-fi from a hobby into big business has been so rapid that a survey of the field, even on a small scale, seemed to be overdue.

It was originally planned that fifty questionnaires would be completed. Forty-eight were obtained but two of these had to be rejected. One of them was from a person who did not own any "hi-fi" equipment, and it was only the opinions of owners which were being sought. The other was from the owner of a so-called "packaged hi-fi" system i.e. all the components are purchased assembled in one cabinet.

Many of the questionnaires were completed by Bell Telephone Company personnel, while others were from personnel in two of the electronics firms in Montreal. Only one female filled out a questionnaire. Two of the forms were completed in the United States, and these did not deviate in any startling way from the Canadian answers.

There were several reasons for restricting the persons surveyed to owners. In the first place only people using equipment have gained the necessary experience to give accurate opinions. There are many "hi-fi" experts today who base their opinions on an occasional audio show, and the thousands of theories and advertising claims which appear in magazines and textbooks.

A second reason for surveying the owners was an economic one. The beginner in the high fidelity field is so overwhelmed by available equipment that he usually seeks advice from an owner. Thus, future sales depend to a large degree on the opinions of present owners.

For purposes of this report a high fidelity system has been defined as one which has been assembled from separate good quality major components, and not bought pre-assembled in one cabinet.

*The Bell Telephone Company of Canada, Montreal.

Loudspeakers and enclosures

In a book entitled "Home Music Systems," E. T. Canby[1] states that the speaker and its enclosure are so tightly interdependent that it is not at all easy to evaluate them separately.

Under the point system of scoring (3 points for first choice, 2 for second and 3 for third) speaker systems received 79 points, more than the combined totals of all other sections of a system which people mentioned as the weakest link. Apparently many hi-fi owners agree with H. D. Weiler[2] when he says that "The loudspeaker comes very close to being the most important component in our high-fidelity system. This single device must reproduce acoustically the sounds created by many musical instruments. These instruments are so varied in construction and materials that it is truly astounding to find one device that will reproduce them all faithfully."

Did you build your speaker enclosure?

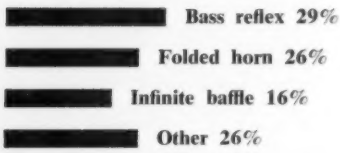
Of those questioned, 72% built their own speaker enclosure. This includes those who had a cabinet built to their specifications, but it excludes those who purchased a factory built cabinet. The answers show that there still is great resistance to buying speaker and enclosure as one package. This probably is due to the price, as a cabinet and speaker engineered and built to function as a unit usually cost more than the speaker and a cabinet bought separately.

Only one person reported building a speaker enclosure from a kit.

Where was your speaker manufactured?

Only one person indicated Japan as the country of manufacture for his speaker. This man had been in the hi-fi field for one year and this could indicate a new trend. The last three years have seen a big influx of Japanese radio equipment, including test equipment, speakers and pickup arms, all underselling the equivalent British and American items.

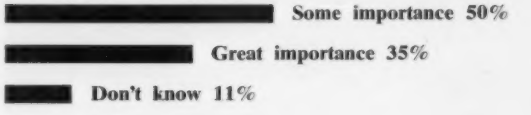
What type speaker enclosure do you have?



The speaker enclosure still is a controversial item. The bass reflex edged out the folded horn, but there were a large number of "other" reports. Both Americans polled reported RJ enclosures, and another man reported a Briggs sand-filled enclosure.

It is interesting to speculate on the type of enclosures that the others may have. Acoustic labyrinths or "boffles" may be the answer, but it seems unlikely that any person working with hi-fi equipment is still using a flat baffle or open-backed enclosure.

Will electrostatic speakers have importance in future?



Record changers, turntables and pickups

The results of the record changer vs. turntable question were inconclusive but "the country of manufacture" and the "type of pick-up" results were very conclusive.

One person put under "further remarks,"

"There is no Hi-Fi changer and there probably never will be."

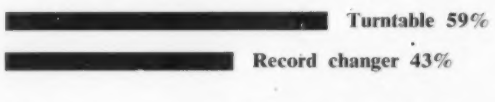
This seems to be an extreme view.

If it is a fact that record changers have inherently more rumble than turntables, it is also a fact that a good record changer is better than a poor turntable. Many turntables which are sold are in the fair to poor category. Record changer rumble, like most other faults in an audio system, can be overcome to the point where it is no longer objectionable in a real sense.

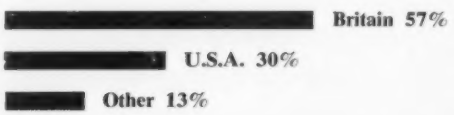
The other great argument against record changers is the fact that the records rub against one another during playing, and fall on one another during changing, both of which cause deterioration. However, this fault is one which will only show up over a period of time, and if a manual position is included on the changer, it is safe to assume that many "Hi-Fi" people play their LP records one at a time.

The changer feature is a compromise to satisfy the rest of the family who like to hear popular music on 78 rpm records. There is of course a definite turntable trend, as the good quality types become cheaper, and more popular music is available on LP records. The "Hi-Fi" owner is not usually too lazy to change a record every thirty minutes if it means greater enjoyment.

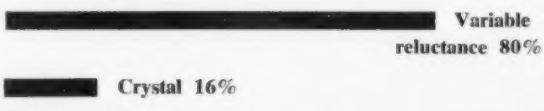
Do you own a record changer or a turntable?



Where was your record changer or turntable manufactured?



Is your pickup variable reluctance, crystal or other?



Records

Records were second only to speaker enclosures as the choice for "weakest link in a system." Many of the complaints concerned surface noise. It appears that there is a market for items similar to the Scott Dynaural Noise Suppressor[3] to overcome some of these faults. One person asked, "Why can't record containers be treated to eliminate the static charges on the record which attract dust?" There are, of course, radioactive devices to overcome these static charges. Many people forget that a mild detergent solution can be used safely to eliminate most ordinary dirt on records.

Variable record equalization is covered under the section on preamplifiers, but it is worth noting that 80% of those surveyed had some form of variable record equalization in their system. The RIAA recording curve has been adopted as a standard by most of the record companies, but there are many older recordings in existence which require equalization.

On records do you prefer classical or popular music?

Prefer classical music 61%

No preference 24%

Prefer popular music 11%

No answer 4%

The answers to this question are interesting when one looks at the statements of a music critic in his book[1] on home music systems. He says that popular music is designed to suit the small radio or big juke box—no huge climaxes and a limited dynamic range. Classical music, however, has everything that only high fidelity systems can reproduce.

Considering both technical and musical features, do you think that American records are superior or inferior to British and European records?

European records superior 29%

American records superior 24%

European & American equal 24%

Don't know 4%

Answer qualified 4%

No answer 15%

Several years ago many hi-fi people were enthusiastic about the London FFRR and the Westminster recordings. Some were of the opinion that there were no American equivalents. These views apparently have been altered with the greater number of American records which are now being produced.

Some British records have been made with frequencies up to 25,000 cps but it is difficult to replay them properly above 15,000 cps due to limitations of the pickups and other parts of the system.

Records operating at 78 rpm, but having microgroove recordings for superior response characteristics have been made in Holland and the United States.

Amplifiers and preamplifiers

It is generally conceded in the audio field that it is no longer difficult to achieve amplification with extended frequency range, and virtual freedom from all types of distortion. This can be done relatively cheaply when compared with speaker enclosures or turntables, and the kit form has been very popular in the amplifier and preamplifier field. This was not always the case however, and arguments are still heard about triodes vs. pentodes, and the various types of feedback or phase inversion.

The Williamson amplifier, and the many variations of it which followed, made a big impact on the hi-fi market. It was surprising therefore, to see that none of those surveyed reported buying an assembled amplifier manufactured in Britain (where the Williamson originated), but 65% reported owning a Williamson or modified Williamson type of amplifier. The answer probably lies in the fact that 76% reported building their own amplifier, and 54% of this number had used a kit. To this writer's knowledge there are no British amplifier kits available in Canada.

Did you build an amplifier or preamplifier yourself?

76% reported yes on both items. Although the figure was the same in each case, not every person had built both.

If your amplifier was purchased, is the country of manufacture Britain, U. S. A. or other?

U.S.A. 82%

Britain 0%

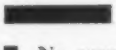
Elsewhere 18%

Percentage of persons who purchased amplifiers 24%

What is the power rating of your amplifier?

Above 20 watts 21%

10-20 watts 57%



Below 10 watts 20%

No answer 2%

The question of "how much power" has been a contentious one for some time. There is no doubt that high-fidelity speakers usually have very low efficiencies (in the order of 5% to 10%), and although some types of enclosures raise this figure, much electrical power is not converted into acoustical power. It is also true that when comparing a 10-watt amplifier operating at full output with a 20-watt amplifier operating at 10 watts, the intermodulation distortion figure for the smaller amplifier is much higher than for the larger one. Finally, it is recognized that an amplifier must have reserve power to handle "transient peaks" such as drum beats, cymbal clashes, etc., without distortion.

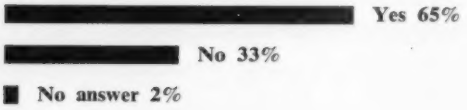
In spite of all these factors however, it is sometimes forgotten that to reproduce a peak level of 100 db in a living room of 3,500 cu. ft., we only require an acoustical power of 0.5 watt from the speaker.

It is worth mentioning here that another factor seems to have crept into power output ratings of hi-fi amplifiers. This is the so-called "English" watt vs. the "American" watt. In the July 1957 edition of High Fidelity magazine there is a report on the Audio Fair held that spring in London, England. Several manufacturers were rating their amplifiers at a certain number of "English" watts. When the author asked several people the difference between English and American watts he got the following replies:

1. American watts are "peak," English are continuous (this from a naive informer);
2. American watts are the maximum that can be obtained at any frequency, British are power at a difficult frequency like 20 cycles;
3. British ratings are conservative because the market distrusts high power ratings.

If this trend of thought develops, and the manufacturers do not adopt some standard of power measurement, the hi-fi field will soon be more confused than it is now. The uninformed section of the public who are interested in good music reproduction will, of course, be at the mercy of the advertiser when power is mentioned. Perhaps the following statement by W. R. Wellman[2] should be kept in mind. "A power output rating means, or should mean, that the power is delivered to the loudspeaker with a minimum of distortion."

Do you have a Williamson or modified Williamson type of amplifier?



Do you have some form of variable record equalization in your system?

A conclusive 80% reported yes to this question. One of the persons who said no mentioned having the new RIAA recording curve equalization only. This variable equalization is usually on the preamplifiers. If a high-level pickup is used, eliminating the need for a preamp, these controls would then have to go on the main amplifier (which might be inconvenient in many cases). Thus one major component of a hi-fi system controls the design of another, with regard to layout as well as electrical features.

Tape recorders

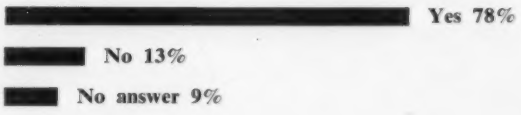
The past few years have seen the popularity of tape recording increase greatly. This is due primarily to new techniques in magnetic recording, thus making it simple for superior recordings to be made at home.

There are advantages and disadvantages to tape recording when compared to disc recording, but a discussion of them is beyond the scope of this report. One author[4] sums it up by saying that the two systems are complementary rather than interchangeable.

The survey showed the great interest in tape recorders as evidenced by the number who eventually plan to own one. It also showed the comparatively small number who own one at the present time. Price is still the obvious limiting factor to a larger number of sales.

Do you own a tape recorder?

If not, do you eventually plan to own a tape recorder?



Two items are of interest in connection with this question. The first one is that although 14% of those surveyed said they were not planning on improving their system in the near future, nine of these people are planning on eventually owning a tape recorder. The second one is the fact that although such a large percentage are planning on owning tape recorders, only 34% feel that a true high fidelity system should be priced over $500.

Tuners

FM radio is a second source of program material for the hi-fi person who does not wish to listen only to the records which he is able to purchase.

There has been much criticism of fm since its inception, some of it uninformed. One of these criticisms was that the same programs were being broadcasted on both am and fm, from a particular radio station. This is not a real criticism of the type of modulation, as even the same program sounds better on fm facilities. This is true when records are the program source because their frequency range has been extended to 12,000 cycles or higher. It is not possible to get this range on am equipment with existing broadcasting regulations. In addition the fm broadcast is free from atmospheric and other amplitude modulated interference, and has a fuller dynamic range. This dynamic range is not duplicated on am, where the operator must cut down the loud passages to prevent overmodulation and distortion.

Last year it was reported that for the first time since just after the war there was an overall gain in the number of fm stations in the United States, i.e. the number of new fm stations was greater than the number of stations being discontinued. Some of the stations also showed a profit instead of being run at a loss by an am station, which has been a somewhat general condition. Thus it appears that future sales of fm tuners will rise. The price is still comparatively high except for the kit forms, and these usually have no automatic frequency control, resulting in considerable frequency drift.

If network programs are brought considerable distances over line facilities, the quality of an fm broadcast may not be too high, but the studios have a much greater selection of recorded music, both on tape and disc, than the hi-fi owner has at home.

Is an fm or am/fm tuner included in your system?

Fifty-nine percent of the group surveyed had fm or am/fm tuners. This figure may be higher than one would expect, but this probably reflects the fact that those surveyed all lived in large cities where there are fm stations available. The limited range and small number of fm stations is another detrimental factor to the sale of tuners.

Who has hi-fi?

Distributors of hi-fi equipment should take note that their potential buyers may be found among the musicians rather than the radio amateurs. 35% of the hi-fi owners polled played a musical instrument, but only 4% were radio hams.

The hi-fi hobby apparently is one which can be started when one is single and continued after marriage. 65% of those questioned were married.

96% of the group expect to be active in the hi-fi field ten years from now. This should be good news for the manufacturers and distributors.

Trade magazines are playing an important role in enlarging the hi-fi field. 67% reported that they regularly read articles on hi-fi in the journals.

The average age of those surveyed was 32.4 years, while the median age, which usually gives a better picture in a survey of this kind, was 33 years. (ages ranged from 21 to 57). From a statistical standpoint the close similarity of the mean and median figures indicates a normal distribution curve for age. The average number of years that the group had been using hi-fi equipment was 4.4 years while the median was 3 years. (The range was from 2 weeks to 17 years). This should also be a cheerful prospect for the sales outlets.

Opinions

What is the weakest link in any hi-fi system?

As many people gave more than one answer an arbitrary point system was used, giving three points for a first choice, two points for a second choice, and one point for a third choice. Speakers and speaker enclosures were far ahead with 79 points, record with 19 was next and the rest followed in this order: pickup and stylus 13, room acoustics 11, turntable 6, and ear 5. The ear was not one which was expected, as it is not a factor which can be controlled or changed. There were four single answers to the question namely, "gullibility of 'hi-fi' owner," "price," "dimension of depth," and "depends on 'hi-fi' set and individual ear."

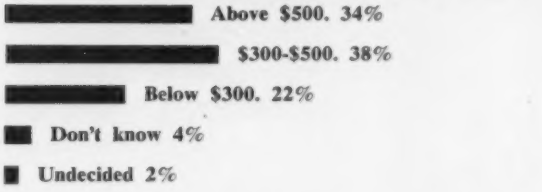
Is the term High-Fidelity misleading or abused?

This somewhat leading question brought the expected high percentage of yes answers (80%). There were some dissenters, however. 9% said no, while 7% had no opinion. 4% qualified their answer by saying the term was abused but not misleading.

Kits gain in popularity

The kit method of building a hi-fi rig is becoming popular. 48% of those questioned said that they had used a kit for some portion of their system. This may explain why one of the leading kit manufacturers recently started a Canadian branch.

How much should a completely purchased hi-fi cost?

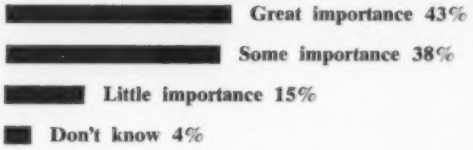


Two points of view were evident. One group apparently wish to keep the standard high now that they own their system. Thus 34% said above $500. The other group seem to feel that the equipment is priced too high, even though it is of high quality. 22% said that under $300 was the proper price. 38% took the middle road and said $300-$500. 4% don't know, and one person was undecided giving two prices.

The July 1957 edition of High Fidelity magazine covers this subject of price in detail under the editorial. Taking the American prices into account (which for many components such as turntables are very similar to Canadian prices), we see this statement: "And thus we come to $220 as the approximate cost of a minimal high-fidelity rig, phonograph only, uncabineted but for the loudspeaker, and uninstalled."

The editorial is quite scathing in its denunciation of an advertisement which offered genuine high fidelity, separate components, completely installed for $89.50. As the editor put it, these people are not in the high-fidelity business, they are in the junk business.

Will transistors have importance in future hi-fi?



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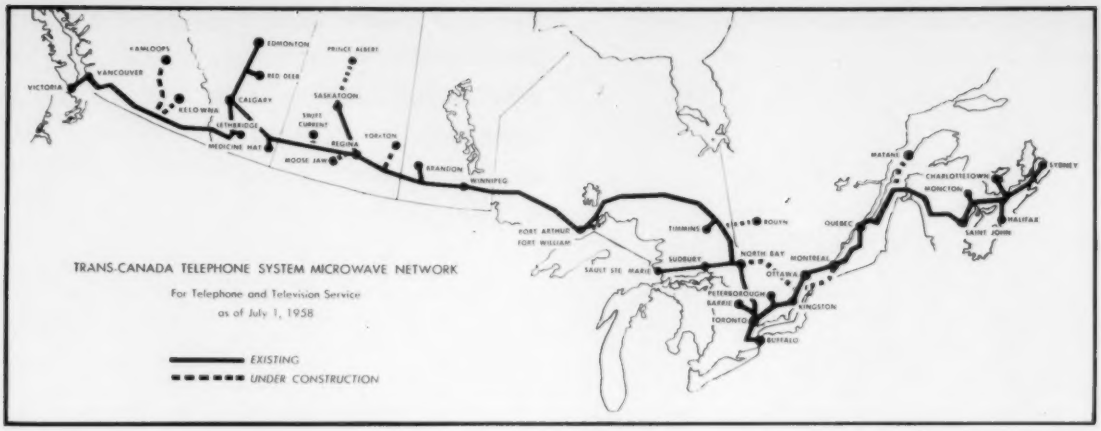


Microwave network now spans Canada

TD-2 system provides better communications service

MEL JAMES*

The principal route of Canada's trans-continental microwave network was recently completed with the opening of the westernmost section terminating at Victoria, B.C. This article gives details of the frequency modulation, transmitting and receiving equipment; antennas and towers; station power supplies and auxiliaries; fault protection systems; and the telephone multiplexing equipment

On July 1, 1958, Canada became linked from coast-to-coast by a communications "skyway" known as the Trans-Canada Radio Relay System. Built by seven of the eight major telephone organizations which comprise the Trans-Canada Telephone System, it is designed to carry large quantities of high-grade telephone circuits and network television from Sydney, N.S., to Victoria, B.C. This represents a distance of 3,800 miles—making it the longest of its kind in the world—and several hundred additional miles of spur line has been or is now being built to connect other major Canadian centres of population with the main or backbone facility.

This dual role of telephone and television service for the nation was accomplished through the installation of a TD-2 System, which is especially suitable for broad-band multi-channel facilities. Operating in the 4,000 mc band with a corresponding wave length of approximately three inches, this TD-2 system has a capacity for six radio channels in each direction. A single channel is able to handle 600 telephone circuits or a black and white or color video signal. Under certain conditions, a channel can handle a video signal and a limited number of telephone circuits as well.

The TD-2 System—which requires conventional line-of-sight transmission paths between repeater stations—was introduced in Canada in 1953 to provide long-distance telephone circuits and television facilities between Toronto, Ottawa and Montreal. Since then, at a cost approaching $50,000,000, the system has been extended from coast to coast. This called for the erection of 139 relay towers and the installation of complex electronic equipment including the use of some 20,000 vacuum tubes which must be constantly on duty. An additional 30 towers are required for the spur lines.

Twelve separate channels

The TD-2 System's 12 channels occupy the spectrum between 3,700 and 4,200 mc. These channels are placed 40 mc apart, with 20 mc used for the channel proper and 20 mc as a guard band between the channels. Alternate frequencies are used for opposite directions of transmission, providing an 80-mc separation between channels transmitting in the same direction. This simplifies the design of filtering arrangements at transmitters and receivers, and the frequencies assigned to a pair of channels are transposed by 40 mc at each repeater station, thereby reducing the problem of over-reach interference between antennas.

In the terminal and repeater arrangements of the TD-2 System, the base band signal from either the telephone multiplex equipment or the television system is applied to a frequency modulation transmitter which produces a 70 mc intermediate frequency. This is heterodyned with the microwave transmitting frequency in the 4,000 mc band and supplied to the antenna through the waveguide. At the repeater station the line frequency is heterodyned in the microwave receiver to produce the original 70 mc intermediate frequency.

*The Bell Telephone Company of Canada, Montreal.

Amplification is provided at this intermediate frequency which is then heterodyned again with a line frequency 40 mc transposed from the received frequency and applied to the transmitting antenna. At the TD-2 receiver, the incoming signal is brought down to 70 mc and then passes through a frequency modulation receiver which produces the original base band signal for either telephone or television purposes.

This radio system operates at low power levels, the output of the individual channel to the antenna being in the order of one-half watt. Because of this, antennas with highly directional characteristics are required to focus the energy into a narrow beam.

Horn reflector antennas

The type of antenna being used over most of the Trans-Canada route is of a new design known as the horn reflector. The antenna is a combination of electromagnetic horn antenna, capped by a section of a parabolic reflector antenna. The apex of the horn coincides with the focal point of the parabolic reflector. In the side of the antenna opposite the reflecting surface, the horn is cut away to form an aperture of about 64 square feet through which the energy passes to the next station.

This antenna is a large device about 20 feet high and 11 feet wide, and weighs about 1,700 pounds. Great accuracy is required in the manufacture of the reflecting surface as its contour must be accurate to within 1/16 of an inch. The antenna is highly directive, providing a gain of 40 db over what the signal would be if it were radiated in all directions. Between the receiving and transmitting antennas then, there is a power gain of 100 million over the isotropic antenna system. The radiated beam width at the half power point is one degree—a factor which imposes some severe design requirements in the supporting tower structures.

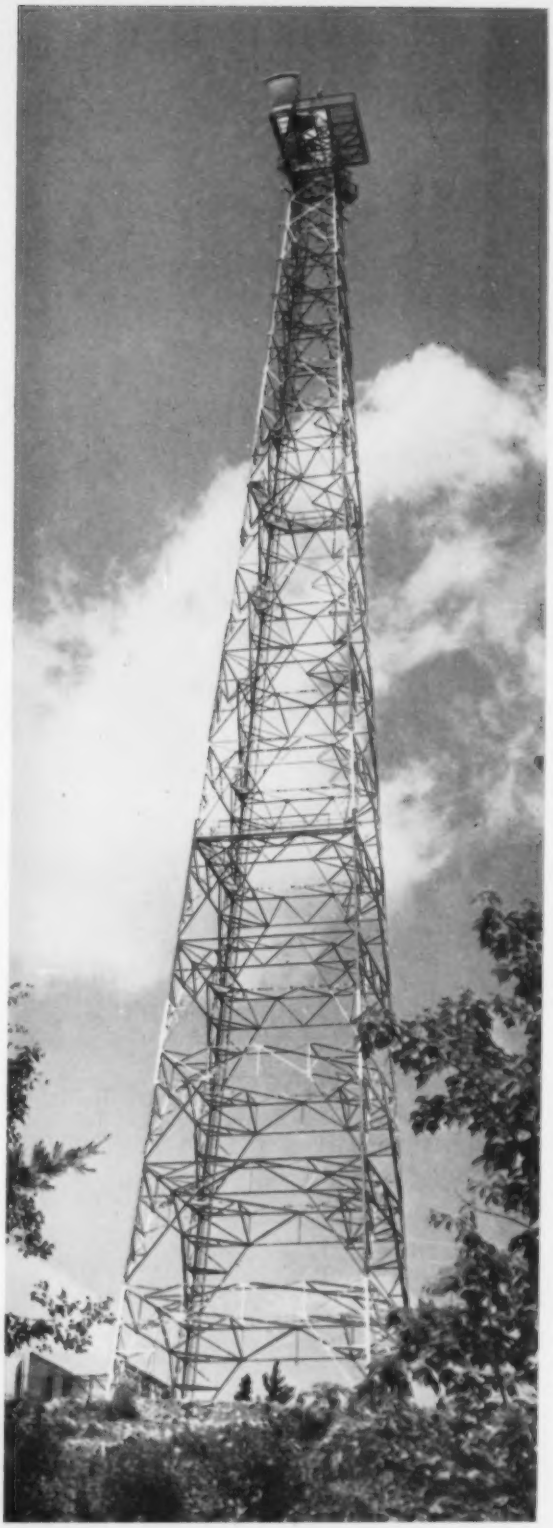
The antennas are connected to the radio equipment by low loss circular copper waveguide having a loss of .004 db per foot and with an internal diameter of 2.812 $\pm$.003 inches. This type of waveguide is used for the long run from the antenna to the entrance of the building housing the equipment at the foot of the tower, while rectangular waveguide is used from the entrance to connect with the equipment. An appropriate coupler is provided between the vertical run of circular waveguide and the horizontal run of rectangular waveguide. The waveguide and antenna system is kept under low pressure of dry air and compressor-dehydrators are provided to supply it.

One of the interesting features of the TD-2 radio system is the 416B electron tubes used in the modulator and in the transmitting amplifier. A planer type triode, these tubes operate at 4,000 mc making the elements and interelectrode spacings very small. The grid wire is .0003 inches in diameter and is wound at 1,000 turns per inch. The cathode to grid spacing is .01 inches so that precise control is required in the manufacture of this tube, which is now being made by Northern Electric Company Ltd.

Station power supplies

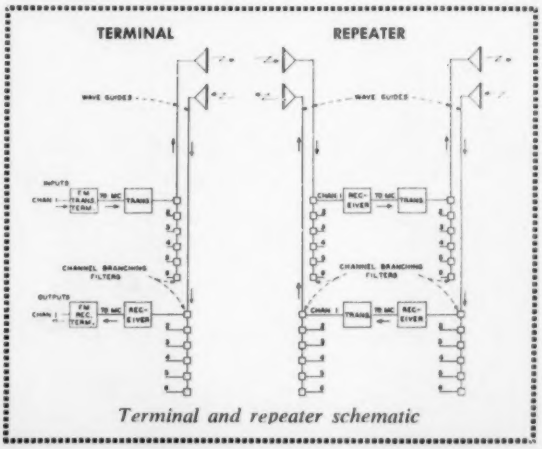
The radio equipment requires direct current power supplies at 12, 130 and 250 volts. A small supply of 24 volts is required for various items of control apparatus in the station. At the smaller repeater stations, the 12 and 250 volts supplies are normally obtained from rectifiers driven directly from the available alternating current source, with the rectifiers being provided on a per channel basis.

The 130-volt supply is from a battery normally floating across a rectifier. A 10-kilowatt diesel-driven alternator arranged for automatic start is provided at each station for use in the event of failure of the incoming ac supply. This engine will take over the station load in a two to five-



Tallest tower is this 350-foot giant. Weighing over 120 tons, it supports two 1,700-pound antennas so rigidly that deflection in 100-mph winds is less than one degree

Close-up view of tower on Fort Rouge exchange, Winnipeg, shows detail of horn reflector antennas. 20 ft high and 11 ft wide, antenna is a combination of an electromagnetic horn capped by a section of a paraboloid of revolution



Terminal and repeater schematic

minute period after power failure, and during this interval, the 12- and 250-volt rectifiers derive their ac supply from vibrators operating from the 130-volt battery.

At repeater stations where it was not economic to build out to the nearest available commercial power line, a large diesel plant designed for continuous operation was provided. Two 20-kilowatt engine alternators arranged for automatic timed changeover are supplied.

The construction of this TD-2 System required the cooperative efforts of a small army of telephone and construction people, as crews of workmen were faced with some of the roughest terrain and the severest weather conditions this country can offer. Truck, snowmobile, aerial tramway and even helicopter transportation was called for to meet the July 1 date for transcontinental television and telephone service over the new communications "skyway."

Tall towers of critical design

In laying out the microwave route, economic factors favored the use of high towers in order to reduce the number of repeater stations required. As a result, many of the 139 towers of the backbone system are over 200 feet high, with one stretching skyward 350 feet.

Because of the highly directional characteristics of the antenna, stiff tower construction with design limits set at one degree deflection under 100 miles of wind, had to be devised. As a result, heavy steel and extensive cross bracing had to be used in erecting the towers which employ a modular design with 12½-foot panel modules.

In the larger towers, the base legs are 8 in. x 8 in. x 1⅛ in. angles, the largest size rolled, and on the tallest towers, this is further strengthened by the use of welded plate to provide a 1⅝-in. angle. The 350-foot tower weighs about 120 tons. The steel is galvanized and it was essential that there was no damage to the surface of the tower while under construction. Because of the galvanizing, rivets were unsatisfactory and galvanized ribbed bolts were used instead.

Because of the height of the towers and the heavy wind loading, footings had to be designed for large uplift. For this reason, large spread footings at suitable depths were required so there was an adequate load of backfill to provide the necessary anchorage. In the 350-foot tower, each footing required an excavation of approximately 175 cubic yards, and the footing and pier required about 43 yards of concrete.

Repeater station equipment

In the interest of over-all efficiency, a standardized layout was devised for the radio, power and auxiliary equipment in the small repeater stations. The building housing this apparatus was made with a floor space of approximately 21 by 35 feet, with the radio equipment, rectifiers, batteries and control equipment located in one room, and the engine alternator and the compressor-dehydrator installed in a smaller room. At locations where locally generated power was required, a separate building was provided for the larger engine plant involved.

As the electronic equipment dissipates large quantities of heat, provision was made for thermostatically controlled forced air ventilation for use during the warmer seasons of the year. During the winter months the temperature is maintained in the low 40s by means of thermostatically controlled heaters. Electric heaters were installed over most of the route, but in some sections where winter temperatures are severe and electric power costs high, oil heating was used. Sufficient capacity was provided in the heaters to allow the temperatures to be raised when personnel are in the building.

Arrangements were made with various power utilities for the construction of run-offs to bring commercial power

to the repeater sites. Only a few locations required diesel plants. Connections to regular land line communication systems were required for the station alarms and controls. This has normally been established by building from existing open wire or cable routes, usually on a joint-use basis with the power utility. In a few remote locations, however, radio was necessary to bridge the gap to the existing communications system.

Because of the importance of the microwave system in the country's communication network, a high degree of reliability was stressed in the design and construction of the TD-2 System. Components of the highest quality were used, and a plan was devised whereby one pair of channels on the route is reserved for the protection of channels carrying telephone and television signal material.

This is done through electronic devices at the receiving end which continuously check the noise level on the radio channels. If it rises above a predetermined amount, a signal is sent to the transmitting end identifying the channel in trouble. The protection channel transmitter and receiver are then bridged to the regular channel, which is disconnected. When transmission conditions on this original channel become satisfactory it is recognized by the switching system, and the original channel is restored to service, with the protection channel returning to its normal standby position. The interval from the time unsatisfactory transmission is recognized until the switch takes place is between 20 and 40 milliseconds and an additional 5 to 10 milliseconds is required to complete the switch.

Smaller stations unattended

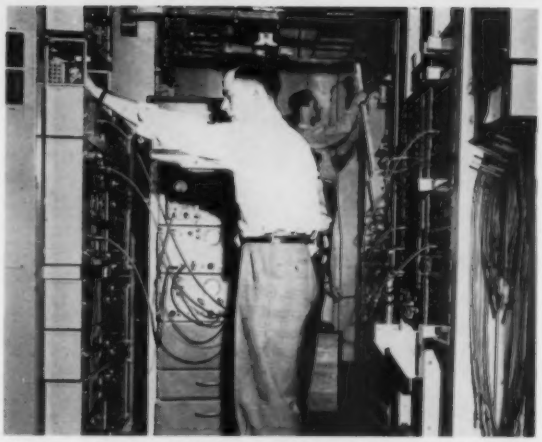
As the small repeater stations are unattended, provision was made for the transmission of alarm information from these unattended points to master stations where maintenance forces are in continuous attendance. This was done by tying in the repeater stations to the regular land line communication system, with a maximum of 12 stations bridged to one set of alarm and control facilities.

When a trouble condition arises, the unattended station affected identifies itself to the master station by means of selective signaling frequencies. The attendant at the alarm centre can dial up the station involved and the alarm system automatically scans conditions in the station and reports its findings on a visual display at the master station. As many as 42 alarm conditions can be scanned in this manner, and certain types of trouble conditions can be corrected from the master station by means of orders sent over the control facilities, making it unnecessary to dispatch a maintenance man until later.

At each of the telephone and television points across the nation, are large installations of telephone multiplex and video transmission equipment.

The telephone multiplex equipment is the well established Type L (coaxial) carrier telephone system. The basic 3,400-cps telephone circuit occupies a band of 4,000 cps, and 12 circuits are modulated to form a group in the band between 60 and 108 kc. Five groups of 12 are then again modulated to form a supergroup between the frequencies of 312 and 552 kc. The supergroups in turn, are shifted in the frequency band to their appropriate place between 64 kc and approximately 3 mc, and then this signal is imposed on the frequency modulation transmitter of the radio system.

The video or picture signal requires a bandwidth extending from dc to approximately 4 mc. This signal is usually transmitted to the studio or television station over 16-gauge shielded pairs using polyethylene insulation. The attenuation-frequency characteristics of this type of facility are such that extensive use must be made of amplification and precise equalization devices to obtain the very flat frequency response required for a satisfactory picture signal. END



Microwave radio equipment section of Ottawa Toll Office contains frequency modulation and transmitter-receiver bays and patch panels for setting up channel combinations

Monitoring and switching panel at Toronto control centre

Television monitoring room at Kingston, Ontario, exchange

Fig. 1. The 25 Bev alternating gradient synchrotron under construction at Brookhaven National Labs., Upton, N.Y. Magnet assembly is 840 feet in diameter. Injector is at the left and target building is astride the tunnel

New machines take closer look at atom

IAN R. DUTTON, ASSOCIATE EDITOR

In their search for information about the structure of the atom, scientists have made effective use of particle accelerators of one type or another. These, in effect, are the microscopes with which scientists can look into the nucleus. The higher the energy imparted to the particle, the more detail revealed in the target. USSR, USA and CERN lead research

The first artificially induced nuclear reaction was demonstrated in 1932 by Cockcroft and Walton at the Cavendish Laboratory, Cambridge. Since that time physicists have devised a number of machines to accelerate particles of one kind or another.

Particle accelerators may be divided into two main groups with subdivisions as follows:

Linear accelerators
- (a) direct
- (b) indirect

Orbital accelerators
- (a) increasing orbit radius
- (b) constant orbit radius

Linear accelerators

Direct linear accelerators such as the Cockcroft-Walton accelerator and the Van de Graaff generators (see "Tandem Van de Graaff," C.E.E., July 1958) are limited in their maximum attainable energy by the breakdown value of the electrical insulators used to construct the machines. However, they are capable of fairly high beam currents and the energy of the continuous beam can be varied quite easily. They are also very stable and can use particles of either sign.

To extend the upper limit of the energy, indirect linear accelerators have been developed. Instead of the beam particles being accelerated through a constant potential they are accelerated down a long evacuated tube by means of a radio frequency potential applied to terminals along the tube. The voltage is phased to travel down the tube with the particle to achieve acceleration. There are variations of this depending upon the particles to be accelerated, and the size is limited by the physical length involved.

Orbital accelerators

Orbital accelerators possess some of the characteristics of indirect linear accelerators in which the path has been made orbital by means of a magnetic field. In all of these the basic equation for the rotational frequency ω of a charged particle moving in a circular orbit in a magnetic field H is:

$$\omega = \frac{v}{r} = \frac{He}{mc} = \frac{Hec}{E} = \frac{Hec}{m_0c^2 + W}$$

where E, the total energy, is the sum of the rest energy

m_0c^2 and the kinetic energy W of the particle, and v is the linear velocity of the particle. e and c are the charge of the particle and the velocity of light in free space respectively, while m_0 denotes the rest mass of the particle which on acquiring kinetic energy W rises to m.

All the orbital accelerators employ this basic equation but derive their different physical characteristics by using different conditions of the four parameters H, r, ω and W.

In the accelerators having orbits of increasing radius such as the cyclotron, the particle moves between the poles of an electric magnet of a constant field strength H which cause the circular path. The particle is accelerated by an rf potential applied to the two hollow metal D-shaped boxes between the poles of the electromagnet. Particles start near the centre and spiral outward in ever-increasing radii picking up energy each time they cross the gap from one D to the other as the electric field strength between the D electrodes alternates. This is shown in figure 2.

This action can be likened to a weight suspended by a string and caused to move in a spiral pendulum motion. The period is independent of the amplitude of the pendulum swing, but is dependent upon the mass of the weight.

This leads to one of the limiting factors for cyclotrons as well as other orbital accelerators, as predicted by Einstein's theory of relativity. Particles approaching the speed of light experience an increase in mass. As m increases the time of rotation becomes greater and the particle arrives at the gap between the D's too late to receive the maximum accelerating potential. This establishes a theoretical upper limit to the energies obtainable from a cyclotron at about 20 Mev.

Phase stability opened new fields

In 1956 Dr. V. I. Veksler, USSR and, independently, MacMillan, U.S.A. discovered the principle of phase stability or the so-called synchrotron principle. It is most easily explained in terms of the electron synchrotron, a simplified diagram of which is shown in figure 3.

In a synchrotron, electrons are first accelerated in a linear accelerator to approximately the speed of light. They are then injected into the synchrotron proper which is a doughnut-shaped vessel surrounded by a magnet. Accelerating electrodes are placed across one part of the doughnut so that an oscillating voltage can provide accelerating potential.

Consider now a stable state of operation with an electron in a circular orbit at the centre of the doughnut. It will be stable if the magnetic field is constant and the electron passes the accelerating electrodes just as the accelerating potential is passing through zero. If for any reason the particle falls out of step and arrives at the electrodes too soon (Fig. 4), it will receive an increment of energy. Since its speed is already close to that of light most of the added energy is converted into mass. This will cause the electron to travel in a slightly wider circle which increases its time to make the next revolution. This will continue until the electron falls back in step and passes the electrode just as the accelerating potential is passing through zero.

The reverse operation is also true and it forms an automatic means of keeping the electron in the correct orbit.

Having found how to keep a particle in a stable orbit, the next step is to devise a means of accelerating it, since if it always crosses the gap at zero phase it never gains any energy.

If the frequency of the oscillator is gradually reduced the particle will, in its next revolution, reach the gap while the field is in the accelerating direction. The tendency of the particle is to reduce its rate of rotation but if the frequency of the accelerating field is reduced at the proper rate the particle will remain in phase and gain energy at every transit of the electrodes.

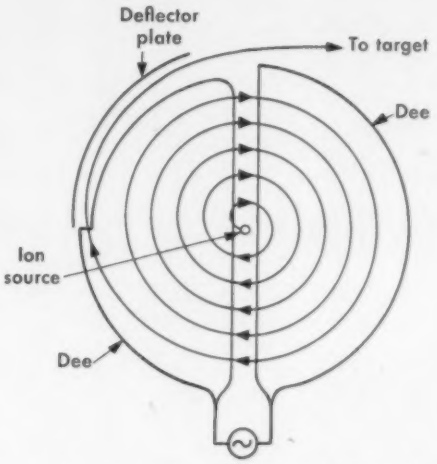


Fig. 2. In cyclotron, particle starts at centre and accelerates in spiral path between the D electrodes

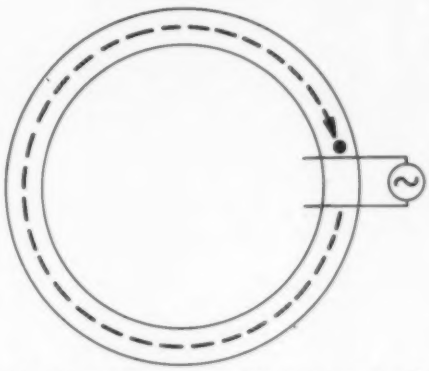


Fig. 3. In synchrotron, particle is injected at high energy and then travels with constant radius

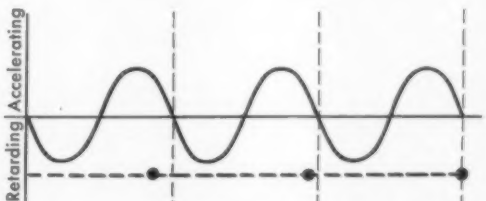


Fig. 4. In synchrotron, particle always tries to cross electrodes as the voltage goes through zero

The same results may be obtained by keeping the oscillator frequency constant and gradually increasing the magnetic field strength H.

The synchro-cyclotron works on much the same prin-

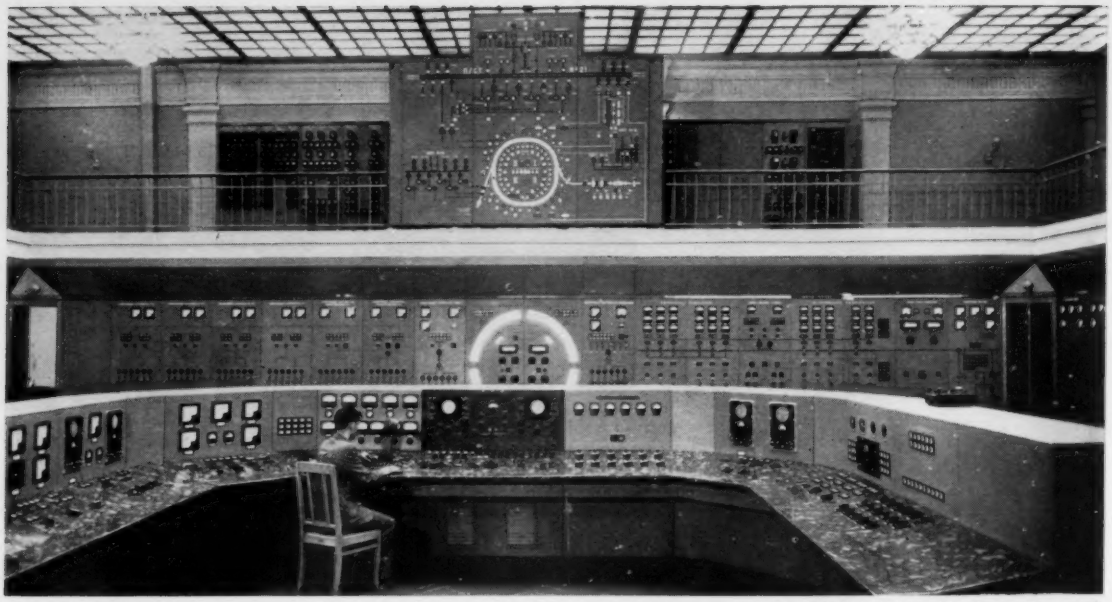


Fig. 5. This is the control desk of the 10 Bev proton synchrotron at the USSR Joint Nuclear Research Institute, Dubna (near Moscow). The general configuration is shown in the control panel at the top of the photo

ciple as the synchrotron except that it is shaped like a cyclotron. The magnetic field is maintained constant while the frequency of the accelerating voltage is varied. The synchronous orbit of the protons is not a fixed circle as in the case of the electron synchrotron but is a spiral as in the case of the cyclotron.

This leads to some rather gigantic magnets, however, since the field must be maintained over the entire area of the D's.

In the proton-synchrotron both the oscillator frequency and the magnetic field strength are varied. In this machine the orbit is of constant radius and the frequency of the oscillator must be increased in synchronism with the increasing rate of rotation of the protons. The magnetic field is increased as the particles are accelerated to keep them in the orbit of constant radius.

It is no longer necessary to maintain constant magnetic field strength over a large area. It need be maintained only over the orbit region with the result that the proton synchrotron may be much larger than, say the cyclotron with proportionately less iron and cost.

This has opened the way for development of massive high energy particle accelerators. The limiting factor is the cost of building such machines but the sizes now are far exceeding the bounds scientists had anticipated only three or four years ago.

U.S.S.R. built first large machine

In April of last year Soviet scientists at the Joint Nuclear Research Institute announced that they had succeeded in placing into operation their 10 Bev proton synchrotron. It is located at Dubna, about 95 miles north of Moscow. There, housed in a large stone building is the accelerator with its 36,000 ton electromagnet. Nearby, are a dozen other large and small buildings to house such things as the electric generators, sub-stations, pumping equipment and controls. The main room of the central building is a round hall containing the electromagnet whose circumference exceeds 650 feet. It looks much like a large ribbed steering wheel.

Before the protons enter their orbit in the electromagnet they must be generated and accelerated to an energy level of 9 Mev. The proton source is hydrogen introduced from a cylinder into a voltaic arc which strips off the electrons leaving the protons. They first enter a simple accelerating tube and gain energy of approximately 700,000 electron volts. Next they enter the linear accelerator to gain their required 9 Mev. before being deflected into the orbit within the electromagnet. The general configuration can be seen marked out on the control panel at the top of Fig. 5. The linear accelerator is to the right of the main electromagnet. Protons proceed in a counterclockwise rotation and are finally deflected off to the target area at the left side of the track.

Once in their orbit, the protons are accelerated and make 4½ million revolutions (2½ times the distance from the earth to the moon) in 3.3 sec.

As the speed of the protons increase the magnetic field H must increase proportionately to keep the protons in their orbit. In the final revolutions of the particle, the strength of the current flowing around the winding of the magnet reaches a peak of 140,000 kilovolt-amperes. The electric stations feeding the magnet use large flywheels on the generators and motors to provide energy for these impulses.

At the beginning of the proton travel, the alternating electric field operates in the region of a few hundred kc, increasing to several mc as the particles gain speed.

All along the 650 foot distance of the electromagnet its poles are set up accurately to within 1/10 of a millimeter. On individual points of the surface, electric tensions reaching several kilovolts are maintained accurately to within 0.01%. The accelerator chambers in which the protons travel are pumped out to a discharge of one billionth part of an atmosphere. 56 diffusion oil pumps pump the air out of the chamber as well as out of the space between its double walls. Around this powerful pumping system flows liquid nitrogen which freezes whatever is left of the gases and steam.

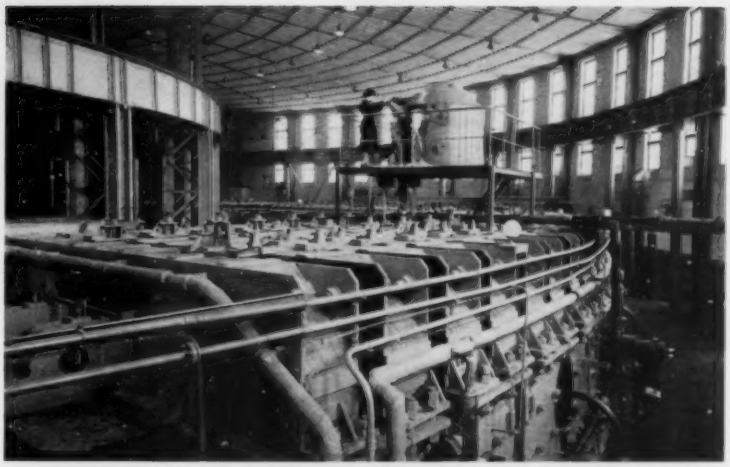
The electromagnet is cooled by a stream of water.

Fig. 6. Part of the electromagnet for the 10 Bev proton synchrotron at Dubna, 95 miles north of Moscow

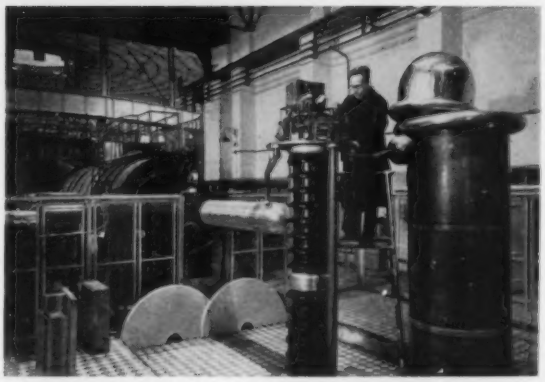
Fig. 7. Protons are first accelerated to 9 Mev before being injected into the main accelerator chamber

Fig. 8. This is part of the electronic equipment associated with the giant 10 Bev proton synchrotron at Dubna

Fig. 9. The USSR Joint Nuclear Institute also operates a 680 Mev synchro-cyclotron in its establishment at Dubna



The central control board is housed in a separate building removed from the building in which the accelerator is located. In action the accelerator emits a beam of radioactive particles which make it necessary to operate it by remote control. The equipment in the target building is also remotely operated and following tests the buildings must be allowed to cool down before people can enter them.



Europe pools its research resources

A number of European countries felt that they were falling far behind the research race set by the Big Two of the world's economy—U.S.S.R. and U.S.A. They had the brain power but not the resources for large scale projects such as synchro-cyclotrons.

In 1949 the French physicist and Nobel Prize winner Louis de Broglie suggested that the smaller countries of Europe establish a common research laboratory. Unesco took up the idea in 1950 and brought the interested European countries together to form CERN (Conseil European pour la Recherche Nucleaire).

CERN immediately embarked on an ambitious program to build two large scale research machines. Their 600 Mev synchro-cyclotron already is in operation at Geneva. The giant 25 Bev proton synchrotron is under construction and expected to reach completion by 1960.

Twelve countries are at present sharing the cost of the CERN research projects. Scientists from non-member countries have been invited to participate, however, and the results are made available to scientists throughout the world.

U.S.A. has ambitious program

Needless to say, many of the engineering design problems have not been mentioned in this article. For example, the particle in an accelerator can wander up and down, even though held fairly close to the designed radius as explained earlier.

Introduction of the "strong focusing" principle by scientists at Brookhaven National Laboratory made it economically feasible to build the large machines such as at CERN and at Brookhaven. Strong focusing is a method of arranging the shape of the magnetic field so that the particles are held more closely to their ideal orbit.

Scientists at Brookhaven are building a 25 Bev alternating gradient synchrotron. The strong focusing principle will permit them to use an evacuated "doughnut" having an elliptical cross section approximately 6 in. wide by 3 in.

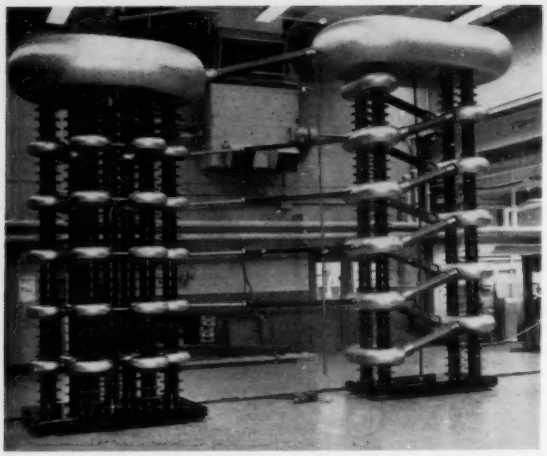


Fig. 10. This is the 800 kv Cockroft-Walton pre-injector for the alternating gradient synchrotron at Brookhaven

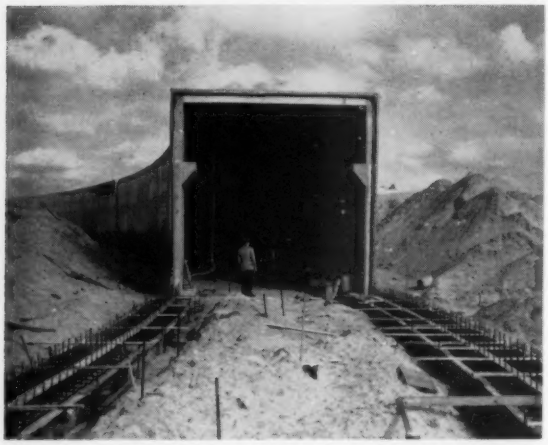


Fig. 11. Construction view of the concrete tunnel in which the magnet for the 25 Bev synchrotron will be placed

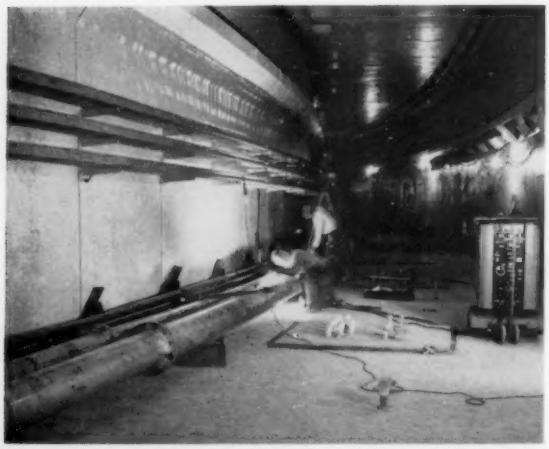


Fig. 12. Workmen start installation of fittings in the half-mile circumference magnet tunnel at Brookhaven

high. This is rather small compared with the 700 ft. diameter of the "doughnut."

Surrounding the particle tube is the magnet assembly dividing into 240 units. Laminations for the magnets use a total of 4,000 tons of steel. The exciting coils are wound with copper bars having a hollow core for water cooling.

The 25 Bev proton synchrotron at Brookhaven is expected to go into operation in 1960 and represents a total investment of about $26,000,000.

What lies ahead

Determined not to fall behind in research work, the U.S.S.R. has announced that it is preparing plans for a 50 Bev proton synchrotron. The magnet will weigh about 22,000 tons and have a diameter of 1,500 feet.

Meanwhile, scientists of the Midwestern Universities Research Association (MURA), Madison, Wis., have built a fixed field alternating gradient accelerator. It is somewhat akin to the cyclotron, but with a specially shaped magnet which provides an improved form of strong focusing.

Major advantages are simplified control with a fixed field and continuous, rather than pulsed, operation. This yields a higher beam intensity which opens up new research possibilities.

When a stationary target is struck by a particle of similar mass, much of the energy is dissipated in moving the target. To prevent this loss of energy MURA designers have proposed a "synchroclash." Two 15 Bev accelerators would be placed side by side as shown in Fig. 13. The colliding proton beams would yield useful energy of 30 Bev.

In a single 30-Bev accelerator, the proton colliding with a stationary target proton would yield only 6 Bev of useful energy. The remainder would be wasted in motion.

There are other theoretical approaches such as utilizing the pinch effect now under development by scientists exploring thermonuclear energy. The pinched plasma would replace the heavy magnet, with a theoretical reduction in cost.

Soviet scientist V. I. Veksler has proposed a scheme in which the accelerating field is confined to the vicinity of the ions. This apparently would move around with the ions. The details were not available when this report was being prepared—and probably would not have been understood by the author anyway.

The method could produce energies up to 1,000 Bev, according to Veksler.

After viewing some of the modern pipeline (oil and gas) projects one begins to wonder if Enrico Fermi's proposal might become a reality some day. He proposed to ring the earth with an evacuated tube and use the earth's magnetic field to obtain a gigantic particle accelerator. It could produce energies of 100,000 Bev. END

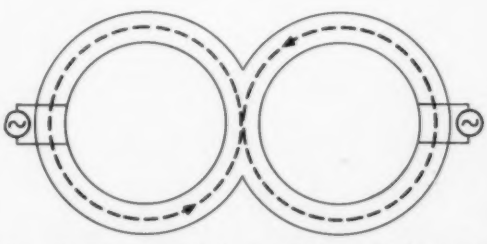


Fig. 13. In synchroclash, particles would be accelerated in two machines, then made to collide to gain maximum usable energy without loss from motion

Picture of mountain-top installation shows rugged terrain in area covered by system. Communication is by microwave from St. Athanase to Trouble Mountain, tropo-scatter from there to Goose Bay and Knob Lake

Commercial scatter conquers Canada's rugged northland

In June 1958, Goose Bay, Labrador was linked by microwave and tropospheric scatter equipment to Quebec City, the rest of North America and most other parts of the world. This is a brief description of the system, with pictures that illustrate the problems of installation in this rugged terrain. A detailed description of the scatter equipment appeared in our July 1958 issue

A. R. HARPER*

During the latter part of 1957 regular shipments of new equipment were being made from Northern Electric's Belleville plant to Eastern Canadian destinations. This equipment was shipped to points of a communication circuit which is now making a tremendous impact on the development of part of Canada's north country.

During the winter months of the year and the spring of 1958, Northern Electric installers took over, actually completing nearly seventy different jobs in the stations between Goose Bay and St. Athanase, Quebec.

At one time, as many as six hundred men were working on these projects, with their greatest concentration at the terminal stations at Goose Bay and Trouble Mountain.

But a year before all this equipment could be shipped on schedule, the company's engineers were working on the special test sets needed and making arrangements for the manufacture and assembly of new items, for the purchase of the necessary raw materials and apparatus subcomponents.

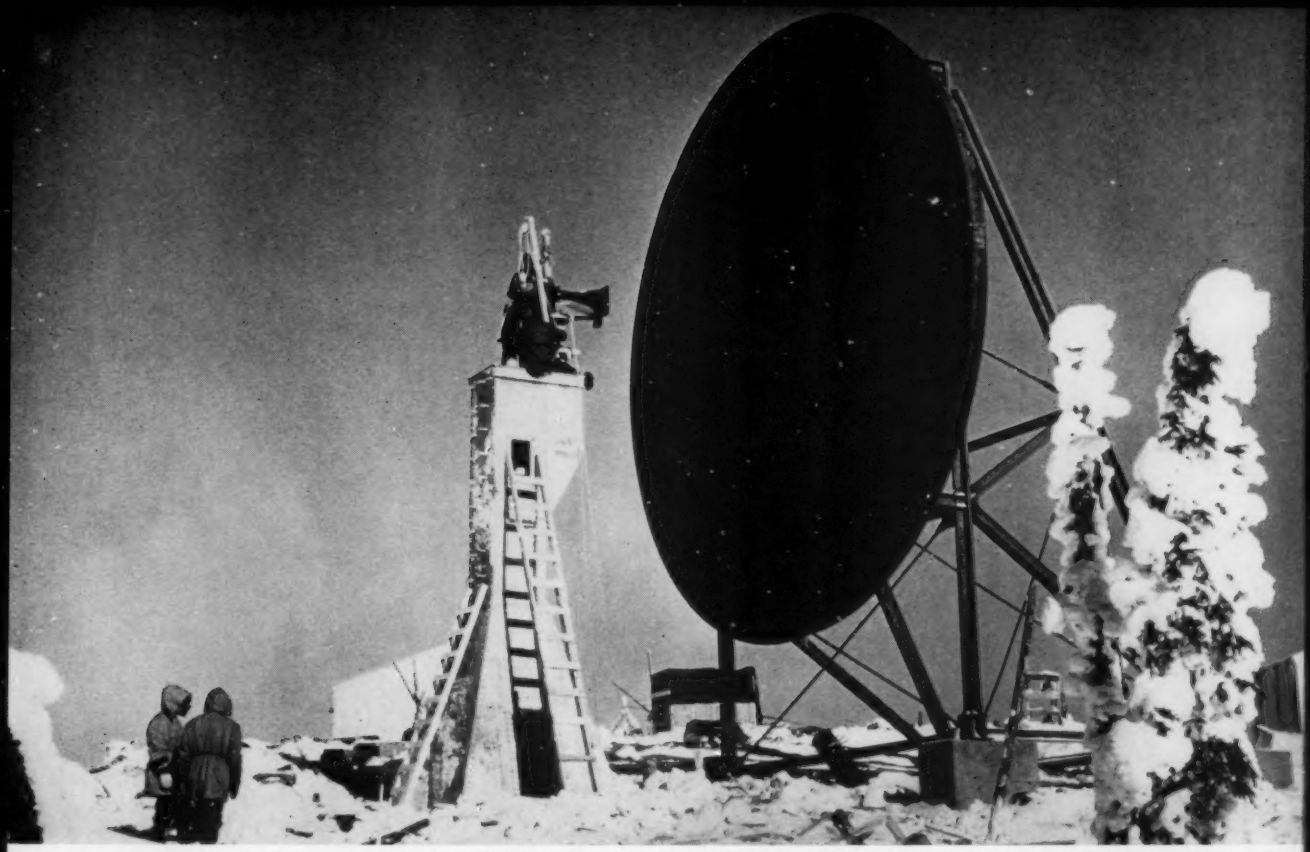
Simulated test conditions

Assembled units were later subjected to exhaustive tests and operated under simulated working conditions in order to make sure that they would function properly when incorporated in the complete equipment.

On the job site, roads and airstrips were built, diesel generators were moved, tons of structural steel for the towering antennae were hauled in and assembled, quantities of electronic equipment were brought in. Many temporary and permanent structures were erected.

Here, between Quebec and Goose Bay, Labrador, over

*Northern Electric Company Ltd., Montreal.



Installation of scatter antenna and paraboloid reflector at Sona Lake, repeater station between Emeril and Goose Bay

a distance of some 400 miles, an area which includes such centres as Schefferville (Knob Lake), Sona Lake, Canatiche, Emeril and Trouble Mountain is now served by the Bell Telephone Company of Canada and Quebec-Telephone over a system which is, in effect, a combination of microwave and tropospheric forward scatter.

At Goose Bay, Labrador, a new dial office has been constructed and went into operation on June 1, 1958, to serve members of the Royal Canadian Air Force, Department of Transport, United States Air Force and residents of the neighboring community known as Happy Valley.

Two hundred channels

These communities are now enjoying, for the first time, regular commercial long distance telephone service over a system which is capable of providing up to 200 channels of telephone circuits, or ninety-two thousand channel miles of communications, over rugged and undeveloped terrain.

Communication circuits serving important locations such as Goose Bay and the Ungava mining district must be of the same quality as the telephone circuits to which we are accustomed in our populated areas.

In much of our Canadian country where pole lines are impracticable, this quality can be obtained by using "line of sight" microwave with which we are becoming increasingly familiar. But in rugged terrain, inaccessible and unpopulated areas, the best solution is the use of tropospheric scatter equipment which can operate over distances in excess of one hundred miles, with repeater stations located in areas of relatively easy access.

With the cutting in of this Labrador installation, and the system in Alaska, known as White Alice, the remote north-eastern and north-western extremities of the continent have been linked by long distance telephone with every town and city on this continent.

The use of the scatter principle necessitates sending large amounts of radio power out into the atmosphere. When a signal is sent out, it encounters turbulence at low altitudes which cause a small amount of it to be directed back to earth. Extremely sensitive receivers pick up this small proportion of the original signal, amplify it and produce a usable signal. Over this resulting single radio circuit it is then possible to use telephone-type carrier equipment which splits the radio circuit into many individual telephone or teletypewriter circuits.

The radio signal is divided into these individually spaced telephone channels by means of Northern Electric's "L" and "K" carrier multiplex equipment.

In order to produce the high power needed for transmission a hundred miles or over, two thousand and ten thousand watt ultra high frequency transmitters are required, in order to ensure toll telephone quality, in addition to large parabolic reflectors, and diversity reception through the use of two or four receivers and critical antenna spacing.

Over sixty feet diameter

Some of these reflectors are great saucer-like antennae, sixty feet or more in diameter. Others resemble the drive-in movie screens encountered in the exurban countryside.

A great deal of experience of value to the designers and installers of this equipment was obtained during the construction and erection of the scatter links used on the Mid-Canada defence line.

In this initial commercial installation, the telephone

circuits will terminate at five main locations. Emeril was engineered as a major branching point and from that location, telephone channels branch toward Schefferville (Knob Lake), which is served by the Cie de Telephone Ungava, Sona Lake and Goose Bay. At Trouble Mountain, fifteen miles from Seven Islands, the through circuits from Labrador pass from scatter radio to Northern Electric TD-2 microwave equipment for transmission over the Quebec-Telephone System to St. Athanase, Quebec, where it joins the Trans-Canada Telephone System's coast to coast microwave network. This network is described elsewhere in this issue.

The equipment for the scatter radio portion of the job alone required over 2,000 vacuum tubes, approximately fifty miles of wire and over one quarter of a million soldered connections. All equipment is provided for northern points in duplicate. If anything should go wrong with one set of equipment, the other set is automatically cut into service, and a signal goes out warning of the trouble.

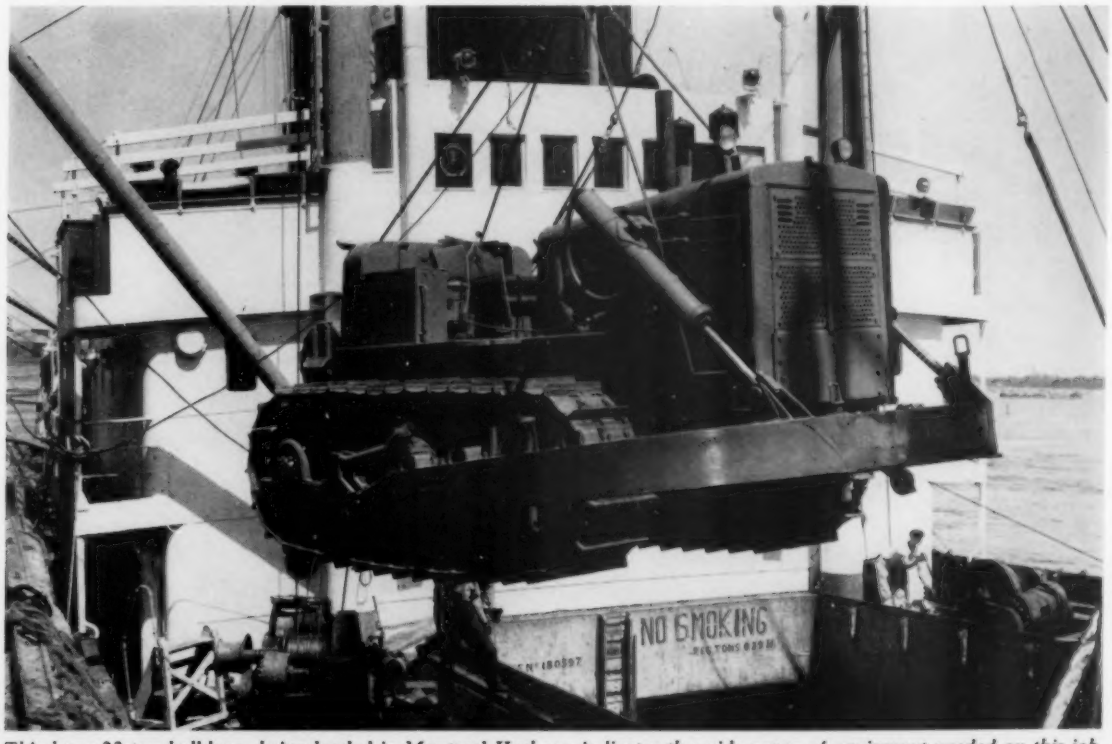
First call June 1

The first official call over the new circuit, from which the last insulator was removed, was made to Vancouver, B.C. at 4.01 a.m. Atlantic time on June 1, 1958. Within a few minutes, however, the operators were taxed beyond their capacity with hundreds of calls for points in other parts of Canada, the United States and Europe.

Radio relay systems and tropospheric scatter are developments of recent origin, but a few years after their introduction we have not only transcontinental microwave but also commercial scatter systems, supplementing more orthodox wire circuits and linking inaccessible points where distances are great and conditions generally rugged.

The Quebec-Labrador installation is a forerunner of other similar systems, which will do much to assist in the opening up of other relatively empty corners of the continent. END

While the rugged landscape surrounding a tropospheric scatter site may differ from a more domestic location, much of the interior electronic equipment is the same as that to be found in many urban central offices. Here, an installer works on a familiar telephone distributing frame



This huge 22-ton bulldozer being loaded in Montreal Harbour indicates the wide range of equipment needed on this job

How quickly does a twin-T respond?

MAURICE PRICE, P.ENG.*

Based on a Laplace transformation to the equivalent pi network, the response of a twin-T network to three different input signals is examined. It is found that the output transient is effectively negligible after about 1½ cycles of the resonant frequency of the network

The familiar symmetrical twin-T of Fig. 1 is one of the most widely used circuit combinations. Among the many applications are single-frequency rejection filters, high and low-pass filters and replacement for LC tuned circuits. The twin-T may be used directly in the transmission path, or as a feedback network.

We will look into the speed of response of the twin-T used directly with several types of input waveform. It is difficult to refrain from posing this question in anthropomorphic terms: "How long does it take for the twin-T to make up its mind to act in the way the designer intended"

The usual Laplace transform method of dealing with transients will be used. It is first necessary to arrive at an operational equivalent circuit. This is done by using two T-π transformations to reduce each T to an equivalent π. The parallel combination of the two T's is then easily effected giving the circuit of Fig. 2. The transfer function of the twin-T is then deduced to be:

$$G(s) = \frac{e_o(s)}{e_i(s)} = \frac{\omega_o^2 + s^2}{\omega_o^2 + 4\omega_o s + s^2} \quad \ldots\ldots(1)$$

In this equation, s is the Laplace operator and ω_o is the "resonant" or rejection frequency of the twin-T, given by

$$\omega_o = \frac{1}{RC} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

*Computing Devices of Canada Ltd., Ottawa.

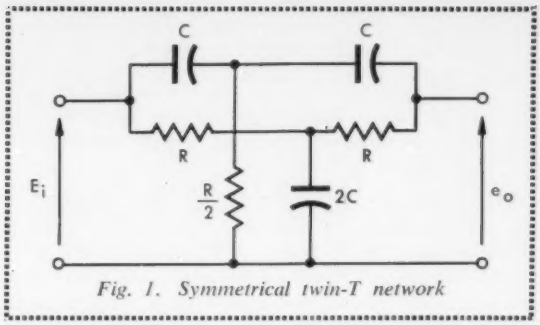


Fig. 1. Symmetrical twin-T network

We have assumed that the source feeding the network is of negligibly small impedance and that the load on the network is infinite. These conditions are usually approached closely in practice.

Sinusoidal input at rejection frequency, ω_o

This is the simplest case to deal with. The input is a suddenly applied signal at frequency ω_o. The sine wave starts at $t = 0$ and has a peak amplitude of E_i. The transform of this signal is:

$$e_i(s) = \frac{\omega_o}{\omega_o^2 + s^2} \cdot E_i \quad \ldots\ldots\ldots(3)$$

Using equation (1), the response will be:

$$\frac{e_o(s)}{E_i} = \frac{\omega_o}{\omega_o^2 + 4\omega_o s + s^2},$$

The solution in the time domain is:

$$\frac{e_o}{E_i} = \frac{1}{\sqrt{3}} \epsilon^{-2\omega_o t} \sinh \sqrt{3}\omega_o t \ldots\ldots(4)$$

This equation is plotted in Fig. 3. The output rises until sufficient information has been passed for the network to "realize" that the output should be zero. The time taken to reach the peak output of $0.218E_i$ is 0.121 of a cycle. After about half a cycle has occurred, equation (4) may be simplified since the sinh term may be approximated by:

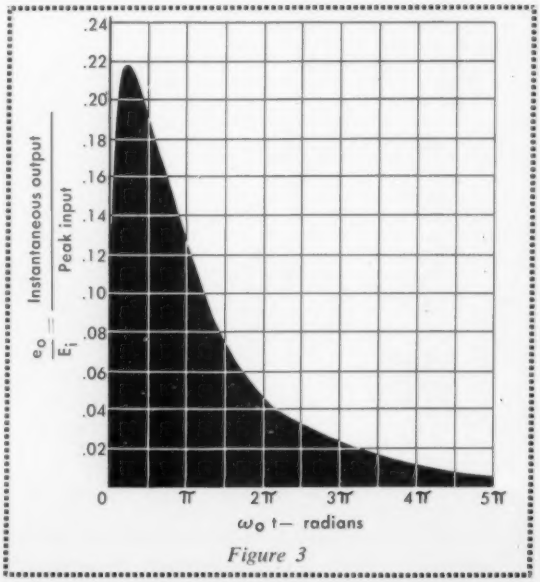


Figure 3

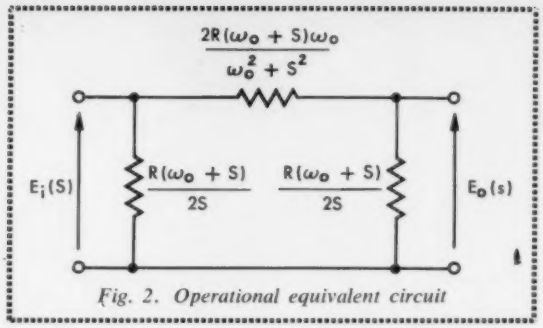


Fig. 2. Operational equivalent circuit

$$\sinh \sqrt{3}\omega_o t \simeq \frac{1}{2} \epsilon^{\sqrt{3}\omega_o t} \qquad (\omega_o t > \pi) \quad ..(5)$$

This approximation turns equation (4) into:

$$\frac{e_o}{E_i} \simeq \frac{1}{2\sqrt{3}} \epsilon^{-0.268\omega_o t} \qquad (\omega_o t > \pi) \quad ..(6)$$

Thus, the tail of the response curve has a time constant of $\tau \simeq \frac{1}{0.268\omega_o}$ seconds. The time taken for the output to drop to 10% of the peak input is about $\frac{5}{8}$ of a cycle; the output falls to 10% of the peak output within $1\frac{1}{2}$ cycles.

Step function input

The response to a step function $\frac{E_i}{s}$ is found to be:

$$\frac{e_o}{E_i} = 1 - \frac{4}{\sqrt{3}} \epsilon^{-2\omega_o t} \sinh \sqrt{3}\omega_o t \quad .....(7)$$

This can be expressed in terms of the response to the rejection frequency already found in equation (4). Let the response given by equation (4) be K. Then equation (7) becomes:

$$\frac{e_o}{E_i} = 1 - 4K \quad .....(8)$$

Hence, the response to the step function can be easily derived, from Fig. 3 and is shown in Fig. 4. At first, the full output appears but this rapidly declines to 0.128 of final value at $\omega_o t = 0.121$ cycles of the rejection frequency. The output then rises exponentially, reaching 90% of final value within $1\frac{1}{2}$ cycles of the rejection frequency. The initial spike is due to the differentiating action of the T with series capacitance.

Sinusoidal input at any frequency, ω

This problem is dealt with in the same way as the two previous ones. It is convenient to put $\omega = \mu\omega_o$ to simplify the equations. The solution is found to be:

$$\frac{e_o}{E_i} = [\cos\theta] \sin(\omega t + \theta) - \frac{1}{\sqrt{3}} \epsilon^{-2\omega_o t} \sinh(\sqrt{3}\omega_o t \doteq \gamma) \cdot \sin\theta \quad .....(9)$$

where: $\tan\theta = \frac{-4\mu}{1-\mu^2}$

$$\tanh\gamma = \left[\frac{\sqrt{3}}{2}\left(\frac{1-\mu^2}{1+\mu^2}\right)\right].$$

In equation (9), the sign associated with γ is to be taken as positive if $\mu < 1$ and negative if $\mu > 1$.

The output builds up to the final value given by the first term. The exponential term will affect the shape of the response in accordance with the proximity of the input frequency ω to the rejection frequency ω_o. The case where $\mu = \frac{1}{2}$ is illustrated in Fig. 5.

There is an overshoot to an amplitude of about 50% greater than the steady-state peak amplitude of the output. This occurs after about $\frac{5}{8}$ of the first input cycle has passed. The transient component of the output is reduced to less than 10% of the peak steady-state output within $\frac{3}{4}$ of a cycle of the input signal, or $1\frac{1}{2}$ cycles of the resonant frequency.

Three types of transient responses have been investigated. In all cases, the output transient is effectively negligible after about $1\frac{1}{2}$ cycles of the "resonant" frequency of the twin-T. END

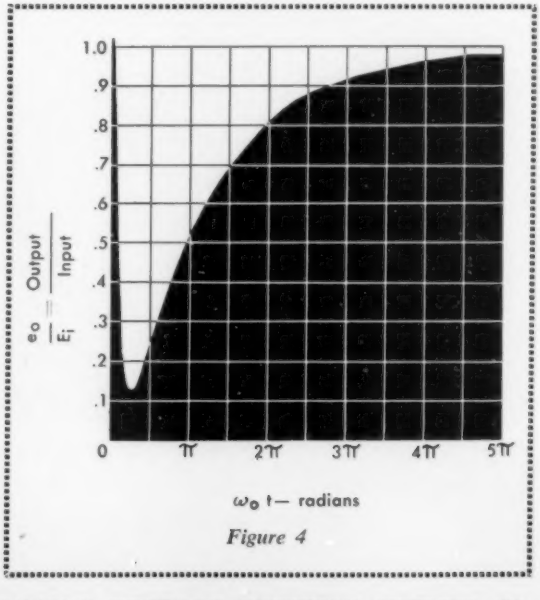


Figure 4

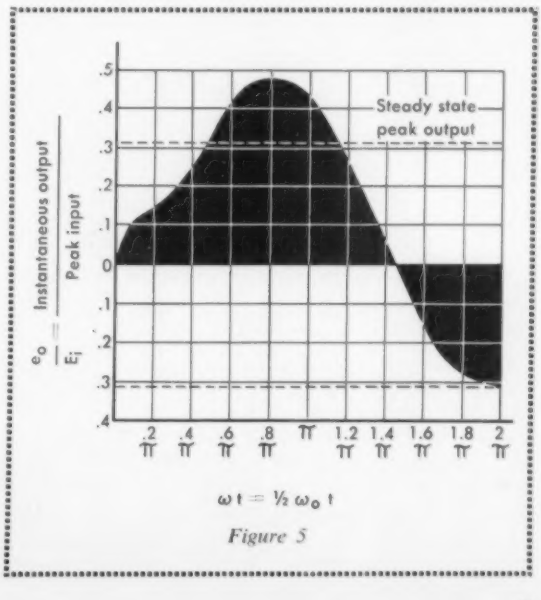
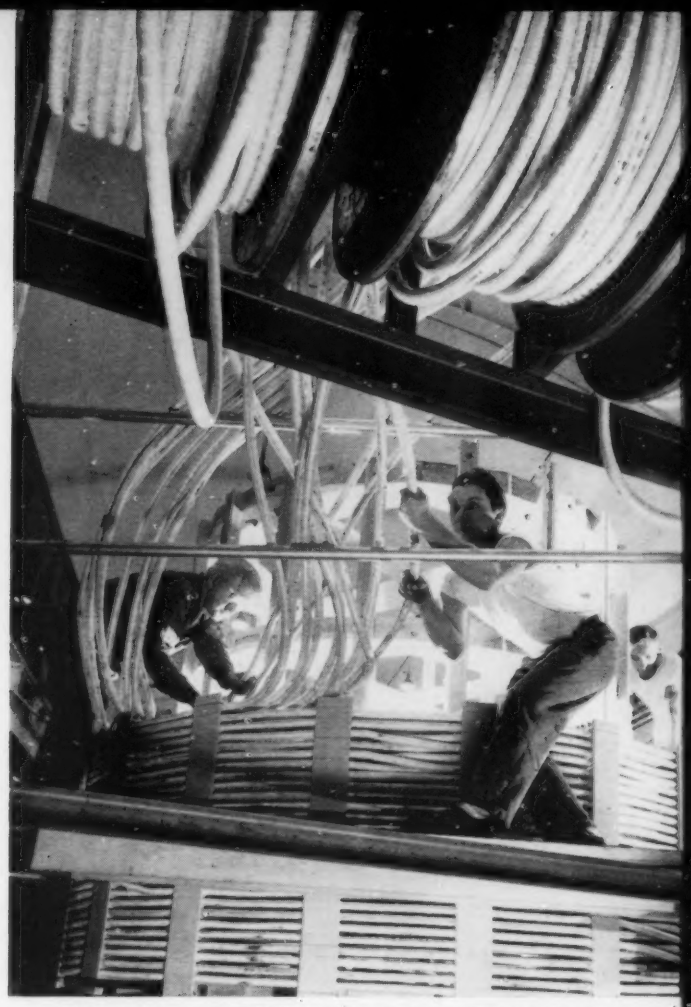


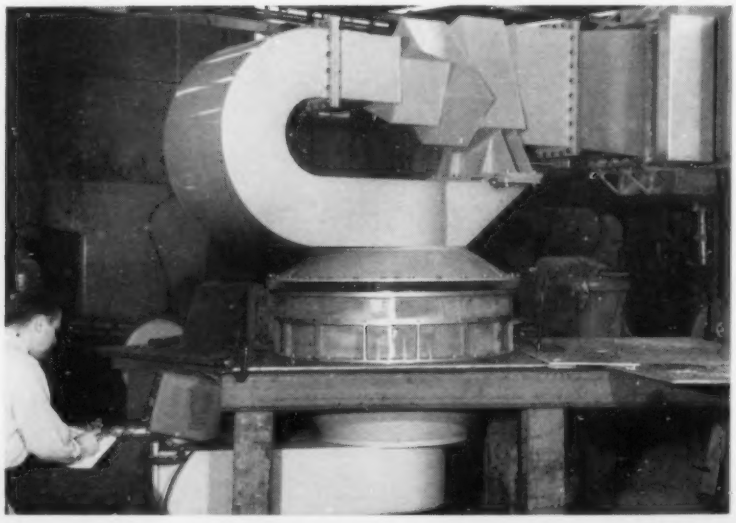
Figure 5

Giant machines extend frontiers of electronics

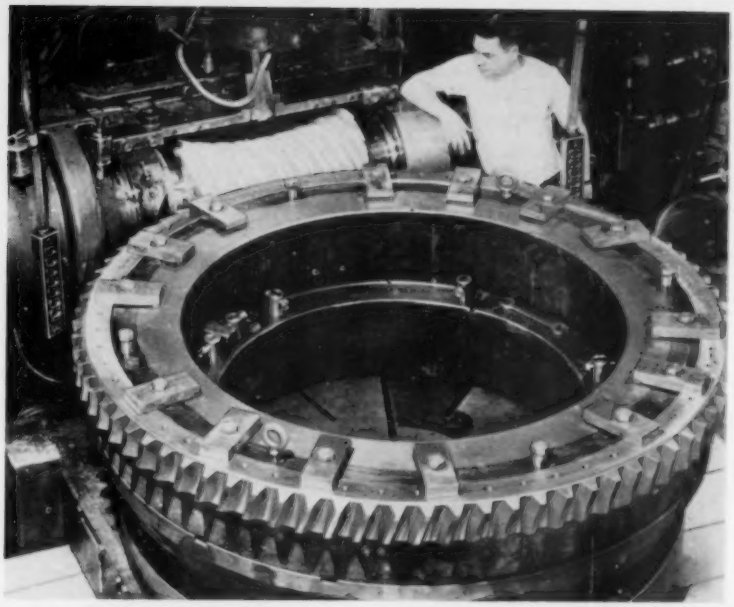
Meet Trimpot, latest addition to staff at Bournes Labs. Calif. He contradicts our headline above.



Huge induction coil built by Westinghouse Electric Corp. supplies energy to electric arc tunnel for testing missiles. Arc heats air in chamber to 40,000 F raising pressure to 30,000 psi. Hot gas rushes through test section to vacuum chamber at 32,400 mph.



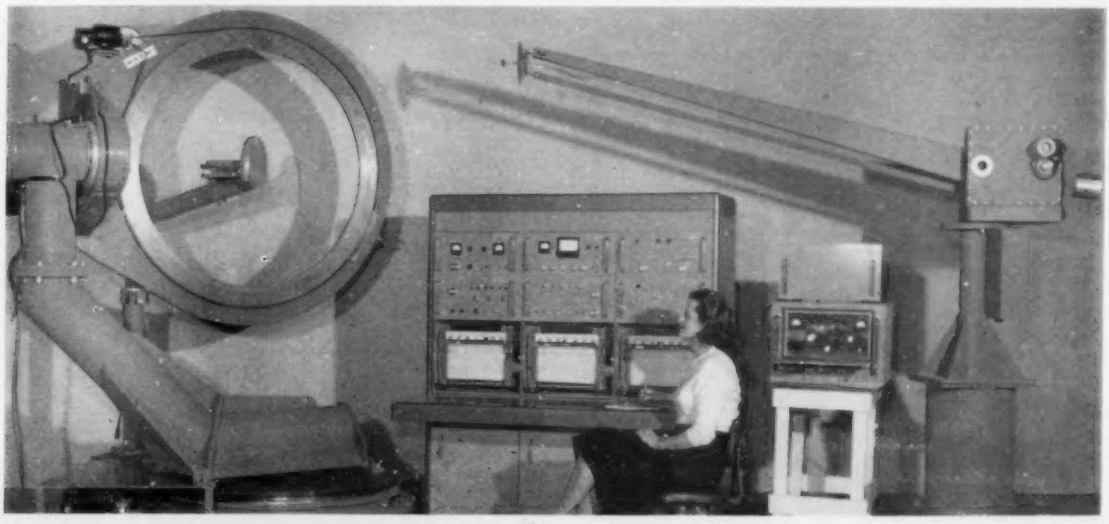
Rotary waveguide joint, 6 feet high, 4 feet wide, will transmit 80 megawatts in UHF band. Sweep is 40 rpm; vswr is 1.2. Built by I-T-E Circuit Breaker Company.



Worm crawls around stationary 50 in. gear as slowly as once per day to drive 84 ft. radio telescope antenna. Built by Cone-Drive Gears, Detroit, drive has reduction of 1,440,000 : 1

Ferranti Limited's "Perseus" is the largest digital computer in Western World built for office work. It can operate directly from letters and numbers in any language or currency

Radome transmission efficiency and antenna patterns can be recorded by this California Technical Industries equipment. Fixture at left holds radome in position while null seeking boom is servo positioned to the beam axis



Is the Canadian electronics industry able to support an annual exposition? Two members of the industry have presented a strong case for the negative. G. Sinclair, General Chairman of the 1958 IRE Canadian Convention, has presented a strong case for the affirmative. Here are their arguments—both worth your consideration

Is the IRE Convention held too often?

The Editor,
Canadian Electronics Engineering,
481 University Avenue,
Toronto 2, Ontario.

Dear Sir:

Canadian Electronic businessmen must learn to recognize that the costs of shows and exhibits become built-in costs which help price products out of the market.

There is an economic limit to the amount of expense which can be budgeted against advertising and sales promotion of any product or product line. A critical analysis of expense in relation to sales in those areas where results can be measured, will indicate where budgeted expense must be controlled or curtailed.

There is definitely a question in my mind if an annual exhibit of the Canadian electronics industry can be justified on an economic basis and particularly this year when expenses must be carefully controlled.

There is unquestionably a segment of the industry, namely the component parts and test equipment field, where an annual exhibit might be justified. However, in the commercial, technical products, or military field, I believe the value of an annual show versus a show on a basis of every three or four years should be given careful consideration.

Very truly yours,

Hackbusch Electronics Ltd.,
R. A. Hackbusch, president and managing director.

Dear Sir:

As a large Canadian component manufacturer who has displayed products in the two conventions held to date we would like to comment as follows:

1. We are very much in favor of such a convention.
2. However, we feel that having this convention every year is too often considering all the factors.
3. It is felt that the convention, to start with, should be held every three years and as the industry grows through the years this could be increased to every two years and possibly with sufficient growth to every year.
4. The reasons for our three year proposal are:
   (a) The tremendous yearly expense of creating and manning a booth.
   (b) The high cost involved in sending delegates to the convention every year.
   (c) The fact that individual manufacturers are continually keeping new products before potential customers through their sales and advertising efforts.

Using accepted advertising allowance percentages, we estimate that considering the total expense involved in putting on this convention, that the combined companies would have to directly attribute ten million dollars worth of business gained through the convention to make it practical. This we hardly think is possible at this time considering the Canadian electronic industry as a whole.

At all times, it is necessary for manufacturers to channel their sales and advertising efforts in order to obtain the best return per dollar spent. It is our considered opinion, and also the opinion of certain manufacturers with whom we have discussed this matter, that having the I.R.E. convention every year is not the most practical method and would be more logical at this time on a three year basis.

Yours very truly,

J. R. Longstaffe Co. Ltd. & Associated Companies,
A. F. Askew, advertising manager.

Dear Sir:

The letters which you have received from Mr. Askew and Mr. Hackbusch suggest that the executive committee of the IRE convention should consider the possibility of holding the convention every three or four years instead of annually. This matter has been discussed at some length at several meetings of the executive committee since the 1956 convention, and each time the conclusion has been that it should be held annually. I should like to outline some of the reasons for reaching this conclusion.

A very important consideration in holding the convention annually is the need for a well-trained organization to operate a show of the magnitude of the IRE Canadian convention. The 1956 convention lacked an organization experienced in operating a professional convention and exposition, and as a consequence many of the IRE committee members had to devote such a large amount of time in advising the convention office staff that their committee duties became quite a burden. For the 1957 convention, the office staff was able to undertake the routine duties so that IRE members were not required to spend unreasonable amounts of time on their convention duties. It is difficult to see how such a trained organization could be held together for a convention held only every three or four years.

Another reason for holding the convention on an annual basis is the matter of leasing a suitable building at a desirable time. There are very few buildings in Eastern Canada with the space and facilities for large trade and professional shows, and they are all very much in demand. The Automotive Building in Exhibition Park, Toronto, is the only building available in Eastern Caanda which has the floor space needed for the IRE Canadian convention. If our convention were to be canceled for even one year, it is unlikely that we could secure the Automotive Building the next year for a convention in October.

The above arguments would, of course, be meaningless if the Canadian electronics industry could not support an annual convention. It is the considered opinion of the Executive Committee that the industry can support an annual convention, and further that there is a definite need for one. It is to be expected that some companies will not be able to justify participation on an annual basis. Such companies will still be able to obtain booth space at future conventions since the limit of floor space available is not likely to be reached for some years. It is quite evident, however, that the majority of companies desire an annual convention.

An annual convention offers a company unique opportunities for advertising its products and services to a select and concentrated audience. The impact of the advertising is increased

(Continued on page 50)

TEFLON* INSULATED

FEDERAL'S NEW HIGH TEMPERATURE HOOK-UP WIRE

CONSTRUCTION—Federal's Teflon insulated hook-up wire has a silver coated copper conductor, insulated with an extruded wall of Teflon tetrafluoroethylene resin having an extremely uniform diameter. Where necessary, an overall Teflon enamelled glass braid and/or shield may be supplied.

Teflon insulated hook-up wire meets the requirements of military specifications MIL-W-16878 for types E and EE, rated at 600 and 1000 volts respectively, and MIL-W-7139 for type RM, rated at 600 volts. Supplied in 10 standard solid colours and up to 3 spiral stripes for circuit identification.

HEAT RESISTANCE—Teflon is suitable for continuous service at temperatures from minus 90° to 250°C. A hot soldering iron in contact with Teflon insulation will not damage it—particularly important where space is limited. As well as withstanding high ambient temperatures, Teflon also permits higher operating temperatures, making possible reduced conductor size with a saving in space and weight.

ELECTRICAL PROPERTIES—Teflon's low power factor, low dielectric constant, high volume and surface resistivity and good dielectric strength are all constant over a wide range of frequencies and temperatures.

CHEMICAL INERTNESS—Wherever there is danger of exposure to solvents or chemicals Teflon in many instances affords the only complete protection. Of all the chemicals encountered in commercial practice, only molten alkali metals and fluorine at elevated temperatures and pressures show any sign of attack on Teflon.

LOW COEFFICIENT OF FRICTION — Teflon has an exceptionally slippery surface—ideal when passing leads through sleeves or similar confined spaces.

Federal's Teflon insulated wire opens the door to new and improved design. Let us know *your* requirements now.

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For further information mark No. 32 on our Readers' Service Card

For your library

High temperature research is new field for electronics engineers

Conference on Extremely High Temperatures

Edited by Heinz Fischer and Lawrence C. Mansur; John Wiley & Sons, Inc., New York; 258 pp; $9.75.

On March 18-19, 1958, the first annual conference on extra high temperatures was held under the sponsorship of the Electronics Research Directorate, Air Force, Cambridge Research Centre. This book is a collection of the papers presented at the conference.

Extremely high temperatures are gaining increasing importance as the basis of thermonuclear reactions. The techniques involved are essentially those employed in the electronic industry and for this reason the subject will assume greater importance in this industry as time goes on.

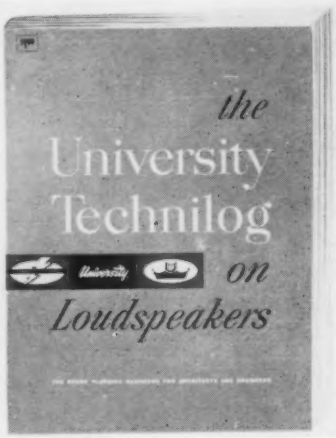
These are the titles of the papers contained in the book.

(A) The Production of Extremely High Temperatures. The Production of High Temperature Gas by Magnetic Acceleration by G. S. Janes and R. M. Patrick; Upper Temperature Limits in the High Pressure Discharge by Heinz Fischer; Combination of Electrically Exploded Wires and Electric Arc by William M. Conn; Analysis of the Direct Current Arc by Alan D. Morris, LTJG, USNR; Inductive Energy Storage — a Tool for High Temperature Research by H. C. Early and R. C. Walker; Remarks on High Current Discharges at NRL by A. C. Kolb.

(B) Methods of Temperature Measurement — Optical Radiation The Determination of the Equilibrium Temperature of a Plasma by Philip J. Dickerman; Recent Developments in Line Broadening Theory for High Temperature Gases by H. Griem; A Microwave Thermometer for Millions of Degrees by J. E. Drummond; Radiation Effects on Rankine-Hugoniot Shock Conditions by Arnold W. Guess and Hari K. Sen; Calculation of the Radical Distribution of Photon Emitters in Symmetric Sources by William J. Pearce;

(C) Plasma Analysis—Plasma Diamagnetism as a Diagnostic Technique by E. I. Gordon; Thermal Diffusion at High Temperatures in Ionized Gases by S. Chapman and E. Tandberg-Hanssen; Stochastic Foundation of Generalized Macroscopic Equations of Change in a Reacting Plasma by H. J. Kaeppeler; Plasma Motors by Winston H. Bostick; The Megatron by David Finkelstein; A Crossed Field Ionic Wind Motor by H. C. Early and W. G. Dow.

(D) Applications—Plasma Acceleration Experiments by Theodore Korneff, F. H. Nadig and J. Lloyd Bohn; The Feasibility of Thermonuclear Propulsion by Milton U. Clauser; Plasma Generation Facility and some Research Results by M. L. Ghai; Behavior of Materials Subjected to Ultrahigh Temperature Environments by J. H. Bonin and C. F. Price; High Magnetic Field Research by Morton A. Levine, John L. Sampson and Ralph W. Waniek.



Sixty-four-page University Technilog provides design data on speakers

Dictionnaire Francais-Anglais des termes relatifs a L'electronique

H. Piraux; Editions Eyrolles, 61, Boulevard St. Germain, Paris V, France; 168 pp; about $3.00.

This is a scientific dictionary giving French words with English equivalents. Several meanings are given for each word so that the reader can select the appropriate translation to fit the sense of the passage being translated. Over 10,000 translations are given for technical terms used in the electrical and electronic industries. This includes many terms from physics, nucleonics, radar, radio, telephone, television, etc.

This should prove of great value to people with only slight knowledge of the French language. It will allow them to read the French literature dealing with electrical and electronic engineering.

Electron-Tube Circuits, Second Edition

Samuel Seely; McGraw-Hill Co. of Canada Ltd., Toronto; 695 pp; $12.60.

This text, familiar to many engineering students and graduates has been extensively rewritten. It now incorporates many of the latest developments in electronics. Notable among these are some of the aspects of transistor theory and application.

"Electron Tube Circuits" has been written as a text book for use in the study of electron-tube circuits. Here the phrase electron tube is taken to mean not only vacuum tubes, but semiconductors and other electron devices which may be used to drive a network.

Rather than dealing in complete circuits, the book presents detailed mathematical analysis of fundamental circuits — oscillators, amplifiers, power supplies, computing circuits, tuned circuits, filter networks fm circuits, and several specialized circuits. This provides the instructor using this text the freedom in organizing his course to suit the particular requirements of the students.

Each section of the book contains a lucid physical description or explanation of the operation of the circuit. This is supplemented with a mathematical explanation wherever applicable.

Each chapter contains a list of reference material and a set of problems pertaining to the material in that chapter.

Physics and Mathematics in Electrical Communication

Dr. James Owen Perrine. (John F. Rider, Publisher) Charles W. Pointon Ltd., Toronto; $7.90.

This is an explanation of what happens in electrical circuits that contain resistance, inductance and capacitance. On a foundation of associated mathematics with numerical examples, the author ties together physical concepts and electrical communication.

Catalogues and brochures from the manufacturers

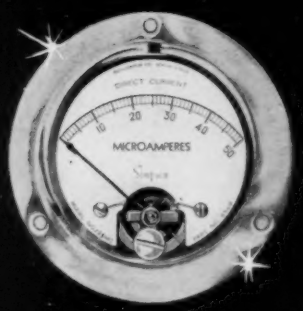
University Technilog on loudspeakers provides practical information on planning sound systems. John R. Tilton Ltd., Toronto (east); Charles L. Thompson Ltd., Vancouver W. (101)

Library Services for business and industry. Brochure describes the services available to business and industry at the Toronto Public Libraries. (102)

Symbols of Specialization is a four-page brochure describing the services performed by the Technical Publications Div. of Electronics Associates Ltd., Willowdale, Ont. (103)

(Continued on page 53)

where modern styling is required...



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For further information mark No. 12 on our Readers' Service Card

Data transmission system operates at voice frequencies

Collins Radio Company is marketing a new high speed data transmission system, the TE-206 (left in photo), which when used with the new Collins 768G-1 Kinecard Converter (middle) and IBM 523 card reader/punch unit (right) reproduces and transmits punch card information at a rate of 100 cards per minute. The system is capable of operating in full or half duplex and simplex modes.

The TE-206 unit conveys information at voice frequencies over wire-line, cable, carrier or microwave telephone facilities. It is completely transistorized to reduce heat and keep maintenance to a minimum. New signalling techniques provide superior signal-to-noise performance and efficient spectrum utilization.

The card reader supplies information to the Kinecard Converter which translates the information and applies it to the eight channels in the TE-206 transmit terminal. At the receive terminal, information from the eight channels in the TE-206 is stored in the Kinecard Converter until sufficient information is available to supply to the card punch unit.

Errors in transmission are detected by odd and even parity checks on each card. Cards in error are identified for re-transmission by offset stacking.

Collins Radio Co. of Canada Ltd., Toronto. (109)

Milli-microsecond switching germanium diodes

Switching time of 0.9 milli-microsecond has been achieved by a new Transitron Electronic Corp. germanium diode model S570G. New manufacturing techniques have resulted in a stored charge (after a 10 ma forward current) smaller than that of a 3 micro-microfarad capacitor at six volts. Another fast diode, the S555 G, is specified at 6 milli-microseconds and offers better dc characteristics.

These diodes are intended for critical computer applications at normal transistor bias levels.

Adams Engineering Ltd., Montreal. (110)

Automatic programming control tape

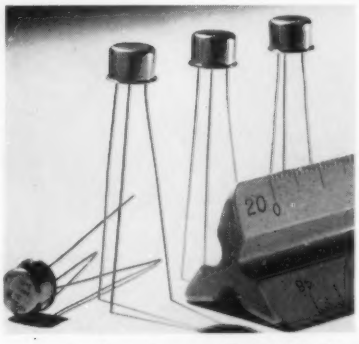
Peerless control tape, designed for use on tape controlled automatic programming equipment, is made of smooth, 0.005-in. thick slate-gray vulcanized fibre. This cellulose plastic tape combines high tensile bending strength with flexibility. It has a tensile strength of better than 6000 psi, high density, low porosity, good abrasion resistance.

The tape will not stretch out of shape during use — an important consideration where photo cells are used. Because of its low coefficient of friction and freedom from impurities the tape produces minimum wear on the perforating and feeding equipment.

Peerless tape falls between paper and polyester film in cost and wearing properties. It has an estimated maximum life of one million cycles while paper, at half the cost, has an estimated maximum life of 10,000 cycles. Polyester film, at six times the cost, has an estimated life of one million cycles and over.

National Fibre Co. of Canada Ltd., Toronto. (111)

High frequency switching transistors



A new line of germanium high frequency switching transistors is being offered by the Semi-Conductor Products Division of Motorola Inc. To be marketed under EIA numbers 2N425, 2N426, 2N427 and 2N428, the new product line features the standard TO-9 package and is designed to meet the electrical and mechanical requirements of MIL-T-19500A.

Motorola Inc., Phoenix, Arizona. (112)

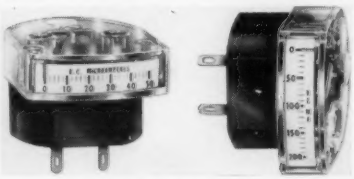
Tinnerman clip mounts transistors

The spring steel Tinnerman Speed Clip has been designed to secure transistors to electronic equipment chassis. It will accommodate all transistors employing the standard TO-9 outline. It is merely snapped into panel holes where it retains itself under spring tension. Its tubular retaining collar has good heat sink properties because it completely encircles the transistor, drawing heat from all directions and transmitting it through the spring legs and tabs into the panel.

Dominion Fasteners, Ltd., Hamilton. (113)

Miniature edgewise panel meter

If panel space is at a premium here is a new Triplett model 120 miniature meter that will fit into restricted panel area. Weighing only 4 oz. this meter also is of value to the user who has a weight limitation factor. It fits a panel hole 9/16 in. x 1-11/16 in. The meter incorporates a self-shielded Bar-Ring magnet, and is not affected by magnetic panels.



The Triplett Electrical Instrument Co., Bluffton, O. (114)

Voltage, current and resistance meter

Model 110 E-I-R meter is an all battery powered instrument for the direct current measurement of voltage, current and resistance. It employs a three tube direct coupled feed-back amplifier with a CK-5886 electrometer tube in its input circuit. The indicating meter is a centre zero type to eliminate the need for a polarity reversal switch. Specifications include: 100 millivolts dc to 1,000 volts dc full scale; 1 millimicro-amp to 300 milliamps full scale; 10 to 100 megohms centre scale; 111 megohms input impedance on volts; accuracy of ± 3%; drift, after five minute warm-up, less than 3 millivolts for the first hour and less than two millivolts per hour thereafter.

R-O-R Associates Limited, Toronto. (115)

Miniaturized pressure transducer

Designed specifically for high speed aircraft and guided missiles, the Fairchild Controls Corp. miniaturized pressure transducer can be adapted to measure absolute, gauge, or differential pressures in the range from 0-5 psi to 0-350 psi with a linearity of 1%. The potentiometer output has a resolution of 0.25% in most pressure ranges.

Designated model TP-100 the transducer is able to operate at up to 2,000 cps at 15g with an output signal transmission error of less than 1%. It will also withstand 25g in the 10-2,000 cps range with no damage or permanent calibration shift. The unit can withstand an acceleration force of 40g with less than 1% error and 75g without permanent damage or calibration shift. It can withstand shock of 50g without damage or permanent calibration shift.

R. D. B. Sheppard, Ottawa. (116)

Transistorized synchronizing tv generator

Primary advantage of the new CGE transistorized synchronizing tv generator is its increased reliability. 56 tubes used on previous models have been replaced by transistors in the new version. It measures 14 in. high, 19 in. wide and 9 in. deep. It weighs about 40 lbs. and requires an input of 135 watts.

Canadian General Electric Co. Ltd., Toronto. (117)

Silicone cable sealant

Union Carbide K-1999 Silicone Cable Sealant is designed specifically for use in cable produced to meet MIL-C-19381A Special Purpose Electrical Cable (Nuclear Plant) Specification.

K-1999 can be easily pumped with conventional sealant handling equipment while still passing the drip test specified in MIL-C-19381A. It has a stable consistency when subjected to extreme temperatures, retaining its effectiveness in the range of —60 to +500 degrees Fahrenheit. K-1999 remains in place without the need of physical confinement and requires no heat curing. The properties of K-1999 make it suitable for sealing and caulking applications where temperature stability and inorganic characteristics are required.

Bakelite Company, Toronto. (118)

Cold weather battery

The Yardney Artic primary battery will operate over a wide range of temperatures — from 200 F to —100 F. Terminal potential is approximately 2.30 volts at —100 F.

The cell, which is non-aqueous, employs calcium for the negative plate, silver chloride for the positive plate and an electrolyte with an acetonitrile solvent.

The cell is hermetically sealed and has no chemical reaction. Therefore, there is no deterioration within the cell. Possible application is in radio equipment and other devices which must operate in low temperature regions, including high altitudes.

Yardney Electric Corporation, New York. (119)

Thin gold helps hi-fi

To produce the hi-fi response of modern stereo and monaural recording heads, a gold alloy strip only 80-millionth of an inch thick has been developed. It is used as a nonmagnetic gap in the recording heads.

Gold has been selected for the nonmagnetic material for the gap because of its noncorrosive qualities. To obtain the necessary hardness it was alloyed with nickel, copper and zinc. The new 18-karat white gold exhibits a Rockwell of C-42, equivalent to the hardness of full age-hardened copper. This white gold is now in commercial production in strips 80-millionths of an inch thin.

American Silver Co. Inc., Flushing, N.Y. (120)

(Continued on page 54)

ASSURED SATISFACTION

. . . is the guarantee we give with each of our products—manufactured by world-recognized leaders of electrical, electronic and communication equipment.

Within this field we supply the highest standard equipment, and our engineers are always available to advise on any problem. Ahearn and Soper's engineering services cover over 10,000 applications.

Radio Communication Equipment for all frequencies • Receiving, Transmitting and Industrial Tubes • Radio Relays—Scatter and Industrial Transmitters, Receivers and Terminal Units • AM, FM and TV Transmitters—Closed Circuit and Industrial TV • Complete Telephone Equipment—Telegraph, Teleprinter and Telex Systems • Intercommunication Systems, Public Address, Industrial, Theatre, Sound, Television and Broadcast Equipment • Analog and Digital Computor Systems • Electron Microscopes, X-Ray Diffraction Apparatus • Electrical, Electronic and Nucleonic Measuring Instruments for field, industry and laboratory applications • Aerial Survey Cameras and Mapping Equipment • Commercial and Industrial Film and Commercial Film Processing and Printing Equipment.

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384 Bank St., Ottawa, Ontario

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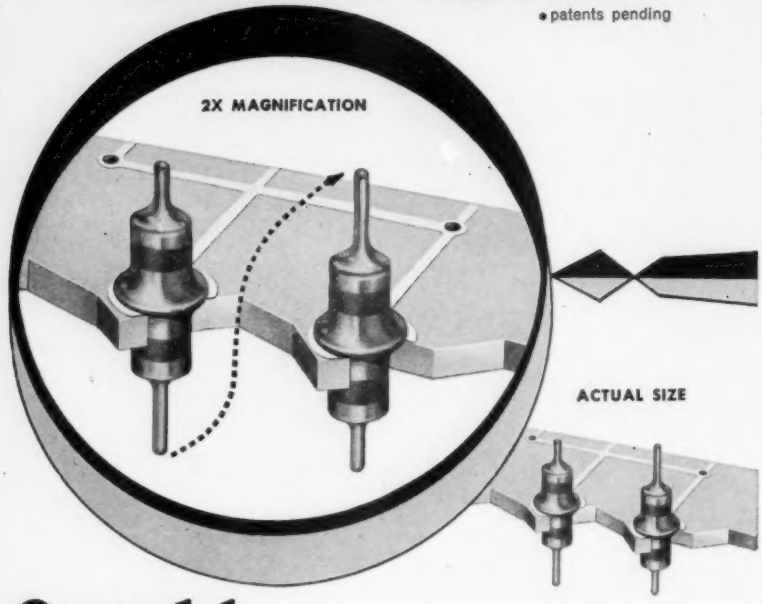
5802-A

For further information mark No. 10 on our Readers' Service Card

Speed Production... Lower Assembly Costs with this New Symmetrical Feed-Thru Capacitor*

*patents pending



Centralab's New DA-741 Hi-Kap,® the feed-thru you can't put in wrong

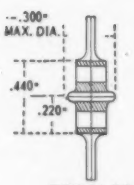
. . . can be inserted from either end . . . a natural for machine insertion or other types of automation

. . . embodies a new metalizing technique that completely eliminates capacitance drop-off, silver migration, and silver burn-off during soldering operations

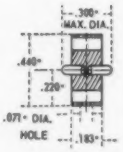
. . . will withstand soldering temperatures of 450°F for two minutes

. . . has a solder fillet around center ring eliminating need for solder preforms

. . . rugged 16 gauge tinned wire lead assures positive connections



TYPE DA 741



TYPE DA 740

SPECIFICATIONS:

Capacitance:	Available in values up to 1,000 mmf. GMV
Power Factor:	3% maximum, measured at 1KC
Voltage:	500 VDCW, 1300 VDCT; special units can be supplied for 900 V. RMS test

DA-740, with same electrical characteristics but without solder fillet or leads, can also be supplied.

For details write for Centralab Engineering Bulletin No. EP-556. For the most complete line of ceramic capacitors in the industry see your Centralab distributor.

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IRE Convention—cont.

by the continuity from year to year achieved in an annual convention. For most companies, the cost of participating in a convention, considered as an advertising cost, is generally a small part of the advertising budget. As with most forms of advertising, it is difficult to assess its value to the company in terms of increased sales. The sales resulting from the convention can never be accurately estimated since the convention is only one of many forms of advertising a given product. It is only on a long term basis that the value of any advertising effort can be assessed.

The advertising of products and services is not the only function of the IRE Canadian convention. A most important function is the exchange of technical information which is so necessary for the continued development of such a dynamic industry as ours. The Canadian electronics industry has reached a degree of maturity few engineers would have realized was possible even two or three years ago. When the 1956 convention was organized it was thought by many that the large technical program of 126 papers represented an accumulation of papers over several years which could not be repeated. However, for the 1957 convention over 150 papers were submitted and for the 1958 convention over 160 papers have now been received. It is most important that the IRE give the authors of these papers every possible encouragement, including the opportunity to present the papers to interested professional audiences. Many of these papers would be lost if the convention were not held annually.

The executive committee of the convention believes that the Canadian electronics industry has already reached the point where an annual convention is a definite necessity. The convention is making many contributions to the development of the industry in Canada by providing opportunities for companies to display their products, opportunities for Canadian engineers to describe their new developments, and, beginning this year with the publication of a record of the convention papers, opportunities for Canadian authors to publish their papers in a Canadian IRE publication. These contributions are much too important to the industry to jeopardize them by attempting to operate the convention on anything but an annual basis.

Yours truly,

George Sinclair,
General chairman for the 1958 IRE Canadian Convention.

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NOV. 31	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
1958	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
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1958	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
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Additional IRE exhibitors

Remaining booth space for the IRE Canadian Convention and Exposition is rapidly being taken up. Latest firms to reserve space are listed below. A complete list—and a wealth of other information about the show—will appear in our special October issue.

Exhibitor	Booth No.
Beama Engineering Ltd., Toronto	564
Canadian General Electric Co. Ltd., Toronto	352
Elder Electronics, Burlington, Ont.	W6
Encyclopaedia Britannica of Canada Ltd., Toronto	129
The Glendon Co. Ltd., Toronto	335
Hope Machinery Co., Toronto	453
Hoyt Electrical Instrument Works, Inc., Cambridge, Mass.	331
Pfeiffer Electronic Laboratories, Trenton, Ont.	237
Premier Metal Products Co., New York, N.Y.	242
Royal Military College of Canada, Kingston, Ont.	436
Secode Corp., San Francisco, Calif.	545
Servomechanisms (Canada) Ltd., Toronto	169
Tele-Radio Systems Ltd., Toronto	547
Universal Winding Co., Providence, R.I.	554

Library—continued

Flexible Electrical Insulation—varnished fabrics and papers, flexible tubing and sleeving, extruded tubing and tape, and special products are described in 52-page catalogue No. 24. Natvar Corp., Woodbridge, N.J. (104)

Electronics in Industry is a 32-page booklet of BTH electronic control equipment with descriptions and illustrations of many typical industrial applications. G-13026. The British Thomson-Houston Co. (Canada) Ltd. (105)

Electronic optical tracking system. Equipment built by Contraves AG Zurich tracks and records performance of high-speed airborne objects. 12-page descriptive catalogue. J. W. Fecker, Inc., Pittsburgh. (106)

Design of pulse magnetic amplifiers and pulse magnetic amplifier logic circuits. These two papers are contained in Application Notes 5 and 6. Hoffman Electronics Corp., Evanston, Ill. (107)

Series 20 miniature connectors are the subject of the 40-page catalogue 20-458 issued by DeJur-Amsco Corp., Long Island City, N.Y. (108)

MUIRHEAD Synchros are best!

Backed by more than twenty years' manufacturing experience, MUIRHEAD synchros and servomotors are built to the highest standards of quality.

The constantly expanding range of types is made to U.S. Military, N.A.T.O., R.A.E., and Admiralty specifications in sizes from 08 to 23. Stocks of most types are held in readiness for immediate delivery.

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IRE CANADIAN CONVENTION AND EXPOSITION

ELECTRONICS and NUCLEONICS

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The I.R.E. Canadian Convention is the ONE opportunity of the year for scientists, engineers and technicians to see all the latest developments in the field of electronics and nucleonics.

A three day programme of important technical papers, hundreds of outstanding exhibits and special features, combine to make this Canada's largest scientific convention and exposition.

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Programme sent on request

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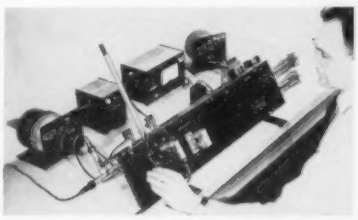
Transfer function meter

The performance of most electrical devices and circuits can be described by specifying a transfer function, which is the ratio of an output to an input quantity. The General Radio type 1607-A transistor-function meter can measure these functions over the frequency range from 25 to about 1,500 mc, and can also measure any two-terminal impedance or admittance over the same range. Among the transfer functions that can be measured are: the "alpha" and "beta" current ratios of transistors, the transconductance of vacuum tubes, the gain of amplifiers, and the loss of attenuators and filters. Transistor and tube characteristics can be measured at these high frequencies under dynamic conditions, and provisions are included for applying dc to both the input and the output of the network under test. The rf signal level can be held below 5 millivolts for low-level transistor measurements.



General Radio Co., Toronto. (121)

The Winston De Luxe tape recorder

This instrument, shown for the first time at the National Radio Show, London, is similar to the Winston Throughbred but has a redesigned amplifier and improved output circuit incorporating a 10 in. moving coil loudspeaker for bass notes and two electrostatic loudspeakers for treble notes. It has a full output of four watts.

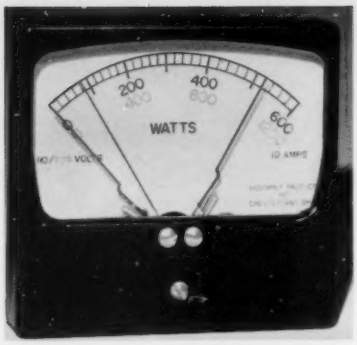
Both the Throughbred and De Luxe recorders use the improved Collaro Mk IV tape deck, which has a quieter motor, more positive drive, faster rewind and a microswitch which automatically stops the motors when the tape is still.

Mechron Engineering Products, Ottawa. (122)

Wattmeter has locking contact

With the locking feature of the model 461-C or 451-C Wattmeter, high and/or low limits of wattage may be set. Control action is initiated when a limit is reached. Limits are set by pointers that may be turned anywhere on the dial.

The new instrument was designed by adding a core magnet movement to the movement of a standard dynamometer type wattmeter. The VHS-type movement is on the same plane as the voltage coil



of the wattmeter, and moves with it as it turns within the field of the stationary current coil.

When the power being used reaches a preset limit, a contact on the indicating pointer touches a contact on a fixed pointer. A circuit is closed to an external slave relay that triggers control action.

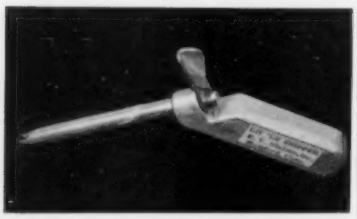
Current through the contacts also flows through the coil of the core magnet movement, which develops sufficient torque (3 grams) to lock the contacts firmly together. To separate the contacts, the locking circuit is first opened. The contacts are then flicked apart by a small spring on the adjustable pointer that was loaded when the contacts met.

In presently available models, capacity of the field coil ranges from one to 20 amperes ac. The instruments are calibrated so that with a given amperage limit, watts may be read and controlled on the dial when nominal voltage is 110, 220 or 440 ac. Standard rating of the core magnet coil and contacts is 25 milliamperes dc, 75 to 125 volts, although higher ratings are obtainable.

Assembly Products, Inc., Chesterland, Ohio. (123)

Wire cutter reaches into cramped quarters

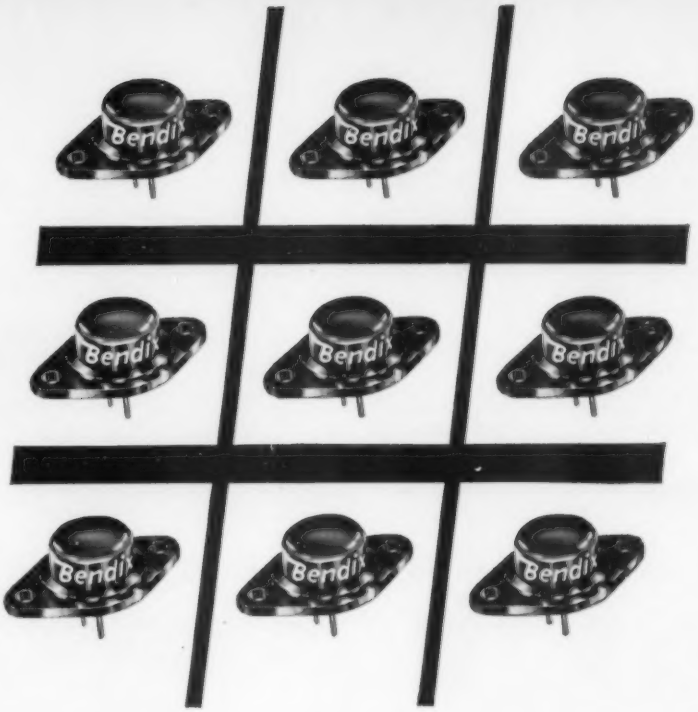
"Little Snipper" uses a radial shearing action at the end of a thin barrel to reach into crowded areas and cut wire. The pistol-shaped handle with spring-loaded thumb lever facilitates use. There is a 10 to 1 leverage on the cutter which permits cutting of copper wire up to No. 8, or stainless steel wire up to No. 20.



The cutter can be used as a pincers to retrieve loose ends or to hold work in place for soldering or brazing. Three standard sizes are available from stock; 2-in., 4-in., and 6-in. Other lengths can be made to order.

E. V. Nielsen, Inc., Stamford, Conn. (124)

(Continued on page 56)



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Now the new Bendix series of nine Power Switching Transistors lets designers select exactly *the* transistor they need to design each circuit for maximum efficiency and economy.

Especially engineered as high current switching devices for DC-DC converter circuits and DC-AC inverter circuits, these transistors are capable of switching up to 250 watts. Available in three current gain ranges for optimum matching, the transistors also have three voltage breakdown ratings to eliminate burn out. Easy to design into circuits, easy to mount, Bendix Power Switching Transistors come in the *standard transistor "package"*. Some other common applications are: relay replacements, drivers for relays, magnetic clutches, solenoids, and other loads requiring high current.

For a wide choice in performance and price to meet your transistor needs exactly, select Bendix Power Switching Transistors. Write for further information to

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Current Gain At 3 Adc	Collector-to-Emitter Voltage		
	40	70	80
15–30	2N639	2N639A	2N639B
20–40	2N638	2N638A	2N638B
30–60	2N637	2N637A	2N637B

CDC — RESEARCH ENGINEERING DEVELOPMENT COMPUTING MANUFACTURING

COMPUTING DEVICES OF CANADA LIMITED

5807

For further information mark No. 15 on our Readers' Service Card

Transistorized voice adapter for type KR carrier

To aid in installation and initial adjustment of power line carrier equipment and for voice communication between power stations in emergencies, a transistorized voice adapter has been developed. It is a plug-in unit that can be plugged into a socket on a carrier set for limited use, where frequent use is unnecessary or undesirable. It is economical because one adapter can be used with several transmitter-receivers.

Both transmitter-receiver and adapter have been transistorized and use less than one tenth of an ampere when the unit is plugged in.

Protective relaying being the primary function, the circuits of the type KR transmitter-receiver and voice adapter are such that the relaying functions automatically take preference over voice communication. If supervisory control is used, it also takes preference over voice communication.

Canadian Westinghouse Co. Ltd., Hamilton. (125)

Industrial ultrasonic cleaner

Narda Series 1500 ultrasonic cleaners comprise the 200 watt "SonBlaster" ultrasonic generator model G-1501 and the 5-gallon transducerized tank model NT-1505. The tank measures 14″ x 10″ x 9½″ deep.

The G-1501 will also power 2 to 4 "SonBlaster" submersible transducers, models NT-604 and NT-605, which can be installed in process tanks, metal-finishing and heavy duty cleaning tanks of varying size or volume.

The Series 1500 "SonBlasters" can be plugged into 115 vac outlet.

MEL Sales, Arnprior, Ont. (126)

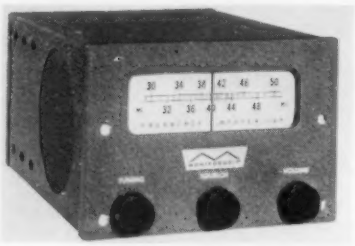
Epoxy micaceous insulation

Reconstituted mica is combined with epoxy binders in the new "Isomica-Epoxy" family of micaceous insulation for use with Class B electrical equipment. The resulting material has good heat and chemical resistance, high electrical properties, uniformity in thin sections and mechanical strength.

The insulation is available in rigid grades in segment plate, molding plate and tubes as well as flexible slot liners, sheets, tapes and combinations. The resin binder may be fully or semi-cured. It can be used in motors, transformer cores, tube insulation, coil bobbins and layer insulation.

Minnesota Mining & Manufacturing of Canada Ltd., London. (127)

Tunable mobile receivers



Two tunable mobile receivers operating in the 30-50 mc and 152-174 mc emergency communication bands have been developed by Monitoradio Division of I.D.E.A. Inc. Model M-40 is for the 30-50 mc band and model M-160 is for the 152-174 mc band. Both of these sets feature double conversion tuned rf stages, 2 mv sensitivity, and built in squelch adjustable from the front panel. They have built-in 4″ speakers and are enclosed in metal cabinets measuring 4½″ x 6½″ x 8¾″.

A. T. R. Armstrong, Ltd., Toronto. (128)

Cartridge kits extend operation of wire cutter and stripper

Cartridge kits have increased the scope and utility of technical devices wire cutter and stripper Mark II. This machine automatically cuts to length and strips insulated wires 14 through 30 gauge—with plastic, asbestos, nylon, Teflon or glass-braided insulation. The kits have been designed primarily to allow self-assembly in plants, job shops, etc. which have to process short runs or where non-repetitive production is necessary.

Each kit includes a fitted hardware case with extra compartments for additional parts, hardened and ground assembly fixture for assembly of cartridge sets, instruction manual, arbors and arbor spacers. Stripping blades and cutting knives are of 18-4-1 high speed tungsten steel.

Technical Devices Co., Los Angeles. (129)

Tape reading and auto-numbering equipment

Telegraph traffic by modern high-speed punched tape systems has led to the necessity for the numbering of messages. Ideally the numbering should be done automatically, and standard or "routine" traffic should also be available without punching special tapes.

British Telecommunications Research Limited have developed for Automatic Telephone & Electric Co. Ltd., a self-contained piece of equipment with built-in facilities which are claimed to meet all the necessary operational requirements. This apparatus, known as the Tape Reading, Auto-sending Equipment, Series TAA, comprises two main units. One section incorporates the tape reading heads and all the operator's functional controls; and the other, which can be remotely mounted on a standard 19 in. rack, is the associated electronic distributor.

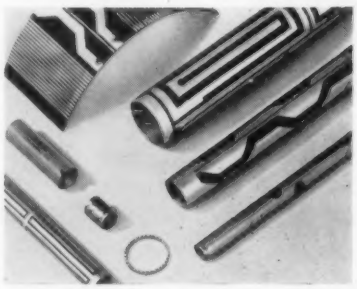
The complete operator's terminal is housed in a unit measuring only 22 in. x 6½ in. x 9 in. high and weighing 31 lb. Two operating heads working on a unique step-by-step principal are provided. Both heads can be loaded simultaneously and are sequentially switched so that as soon as one tape has been read the other head comes into operation.

In addition to the two heads the terminal includes an automatic numbering device, a 100-character test message sender and two 40-character message senders. The first of these 40-character senders is used for the station call sign and the other provides for the automatic transmission of routine traffic.

Automatic Telephone & Electric Co. Ltd., London. (130)

Tubular circuits provide new design dimension

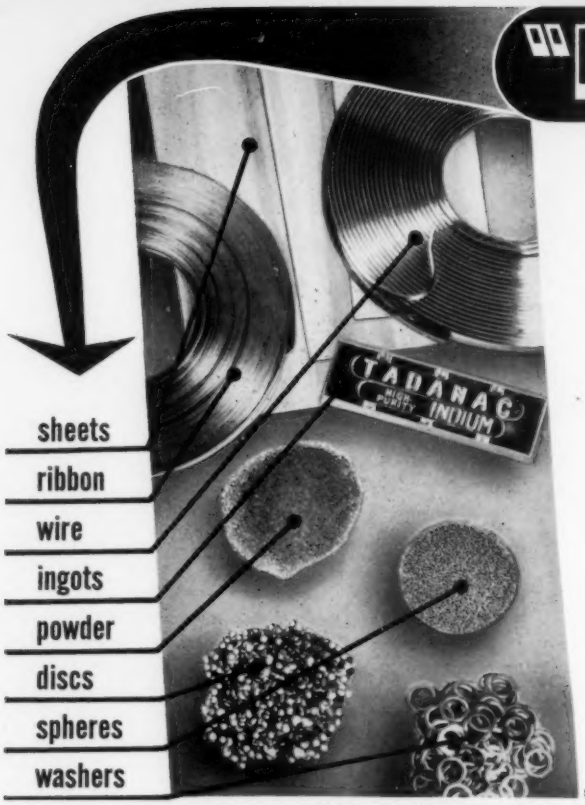
Direct printing of solderable silver circuits on either the exterior, interior, or both surfaces of tubes opens a new area of application for electronic designers. In general, an inside diameter of ½ inch is required for circuitry but continuous coatings for shielding or conduction have been applied to tubes having an inside diameter as small as .020 in.



Motson Circuits may be applied to almost any type of nonconducting tubular material including Teflon, Kel-F, epoxy, phenolic, polyester, silicone, glass, ceramic and thermoplastics. In general, the conductive inks are deposited from 0.0004 to 0.0015 in. depending upon requirements. Pattern tolerance can be held, under some circumstances, to ±0.001 in. The circuits are stable up to 500 F.

J. Frank Motson Company, Flourtown, Pa. (131)

(Continued on page 57)



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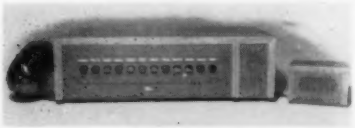
New products — cont.

Intercom telephones

The Fonex transistorized intercommunication system operates directly from the 110 volt supply. It provides nonprivate or private conversations and can be readily switched to permit conferences. It comes in a wide range of sizes to suit the individual needs of the customer.



Telecom Limited, Toronto. (132)

Zener reference strings

Zener reference strings have been designed for applications where voltage output and temperature coefficient requirements are not compatible with performance of a single Zener diode, such as in the precision instrumentation field. The basic building block of the Hoffman strings is the type 1N429 twin anode Zener diode. Cancellation of the temperature coefficient has been employed in the "A" types to achieve performance superior to a random string of single diodes.

The strings eliminate the necessity for designing a special product each time an application arises. The strings are useful in any application where a total stability of ± 0.5% or ± 1.0% over the temperature range of —55 C to +100 C is necessary, and where the operating current of 7.5 ma is adaptable to the external circuit requirements. They have an operating voltage range from 6.2 volts to 49.6 volts; a maximum change in voltage in the —55 to +100 C range of 0.050 volts to 0.200 volts, and a maximum dynamic impedance (at 7.5 ma) from 20 ohms to 180 ohms.

Samuel C. Hooker (Canada) Ltd., Montreal. (133)

Time delay relays

Ebert Electronics Corporation time delay relays feature hermetically sealed, mercury-to-mercury snap action. The series include SPST, 2PST and 3PST relays rated at 20, 35 and 60 amperes or up to 5 hp at 115 vac. A thermal timer is used.

Adjustable "make" delay periods are available, preset, in several ranges covering delays of 3 to 120 seconds. The delay timer settings may be shifted using a standard hex key. The relays are compensated for ambient temperatures from —65 to +85 C, or ambient adjusted to suit application requirements. The timer has a repeat accuracy of ± 5%.

Philips Electronics Industries Ltd., Toronto. (134)

Low voltage regulator

Operating at a nominal 55 volts over the current range of 2 to 30 ma, regulator tube G55/1K was developed to replace the neon bulb type of regulator which has long been a means of stabilizing voltages in this region. The base connections and physical dimensions are the same as the OA2, OB2 series of tubes, to which it is complementary.

Standard Telephones and Cables Manufacturing Co. (Canada) Ltd., Montreal. (135)

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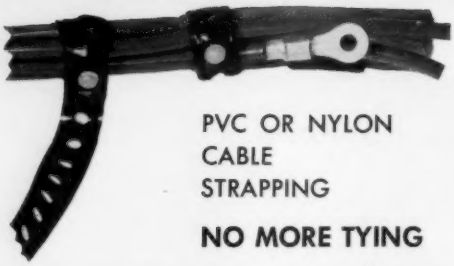

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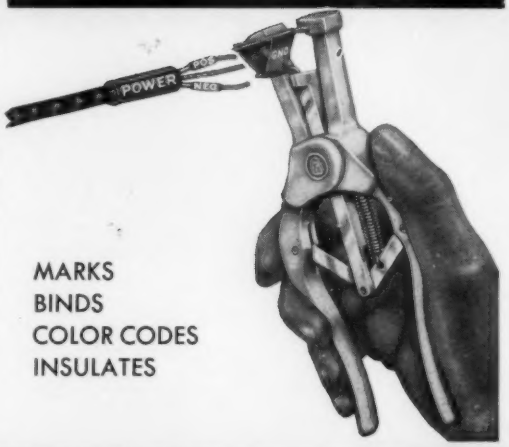

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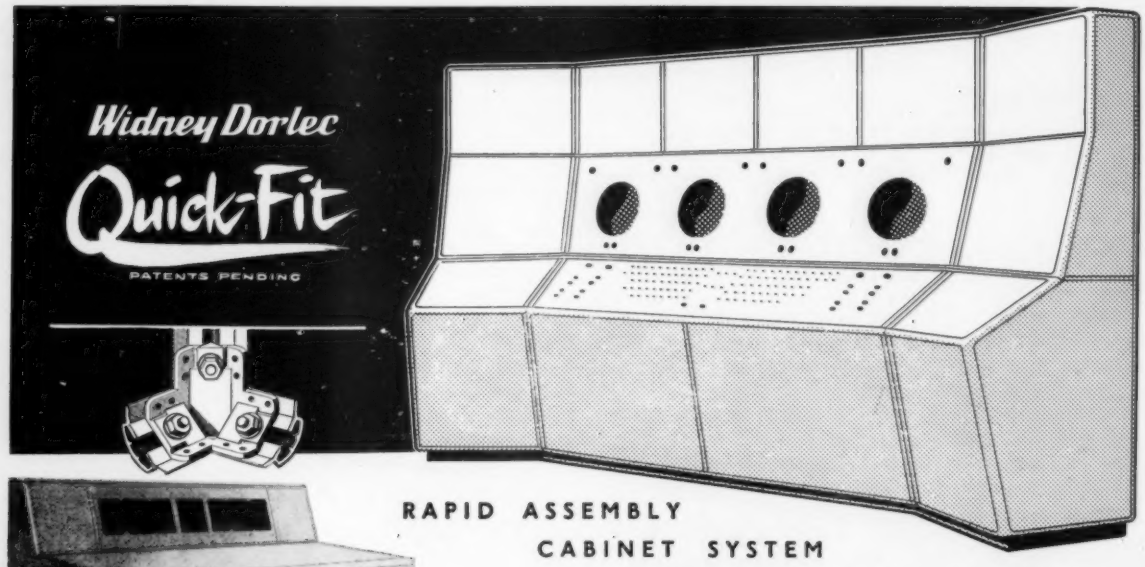

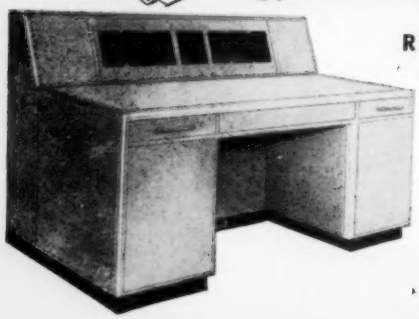

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The advent of the sputniks and earth satellites has brought a new activity for electronics. This tracking station operated by Collins Radio is typical of the many stations used to determine orbits and receive telemetered data

What goes up must come . . . .

Although the first attempt by U. S. scientists to send a rocket to the moon has failed, they have stated that they will make another attempt in September when the moon is in a favorable position.

This could be the start of a hot race between the U. S. A. and the U. S. S. R. At stake is a great deal of prestige which both nations are desperately seeking with world conditions in their present state.

Apart from the political implications, it must be acknowledged that this is a tremendous scientific venture.

Only a few short years ago, the general public believed that the only thing capable of reaching the moon was a certain well-known cow. Technological advances have come so rapidly, however, that we can expect space travel within our own generation.

Current thinking in missile and rocket technology in the various armed services and in industry will be explored in Detroit this month at the national fall meeting of the American Rocket Society.

Among topics to be discussed are both long and short range missiles; the impact of space flight on industry; controls for supersonic air-breathing engines; latest developments in monopropellants and operational service problems.

In Canada, this subject will be discussed at the Astronautics session during the I.R.E. Canadian convention. Members of the Canadian Astronautical Society are carrying out a very active program with technical sessions, workshop sessions and experiments such as the construction and firing of missiles.

This is a field in which electronics engineers can expect to become more active, not only in instrumentation, but also in the development of propellants for high-speed space travel. Such things as ion guns hold some promise for future practical use as propellants. This is within the realm of electronics and is an area worth watching.

New TV stations

More than 60 TV stations are being blueprinted and built this year in the most diverse parts of the USSR: in Alma-Ata, Kazan, Kemerovo, Karaganda, Perm, Petrozavodsk, Piatigorsk, Ufa, Chelyabinsk, Ulianovsk, Voroshilovgrad, Dniepropetrovsk, Ust-Kamenogorsk, Makhachkala, etc. About 30 of these will start functioning this year — Soviet News Bulletin.

We in North America tend to think of Africa as a land of eternal sunshine. This could have some unexpected advantages. Kojo Botsio, Ghana's Minister of Trade and Industries recently discussed the possibility of using solar cells to power radio receivers in remote villages of Ghana. Idea was presented by Maurice Paradise, Hoffman Electronics Corp.

COMING EVENTS

September

15-17 Power Industry Computer Application Conference. King Edward Hotel, Toronto.

16-20 International Nuclear Electronics Conference, UNESCO House, Paris, France.

24-25 IRE-AIEE Industrial Electronics Conference. Detroit, Mich.

25 EIA-IRE Golf Tournament. Scarborough, Ont.

28-Oct. 2 Fall Meeting Electrochemical Society. Chateau Laurier, Ottawa.

October

8-10 IRE Canadian Convention. Exhibition Park, Toronto.

13-15 National Electronics Conference. Chicago.

22-24 Fifth National Vacuum Symposium. San Francisco.

26-31 AIEE Fall General Meeting. Pittsburgh, Pa.

27-29 EIA-IRE Radio Fall Meeting. Rochester, N.Y.

29-Nov. 1 1958 Montreal High Fidelity Exposition, Windsor Hotel.

Special issue for IRE Convention

With October comes the IRE Canadian Convention and Exposition in Toronto. Canadian Electronics Engineering is preparing an important pre-show issue which will give readers all the information they want about every aspect of the convention. This special issue will include:

Complete details of the technical program with abstracts of all papers.

Full list of exhibitors, booth numbers, personnel, with details of products to be shown.

Special illustrated section containing technical information on New Products to be seen at this year's show.

Easy-to-use plan of exhibition floor with reference list of exhibitors.

List of events, officials and other general information, including map of Toronto.

This outstanding October issue will also include feature articles and regular departmental news coverage.

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Model 460A provides voltage gain of approximately 20 db while Model 460B is a 15 db terminal amplifier insuring maximum output. Since rise time is 0.0026 μsec, and overshoot and ringing are negligible, distortion-free amplification of pulses faster than 0.01 μsec is assured. The high gain, no distortion feature means the instruments, in cascade, serve as a 100 MC pre-amplifier for standard oscilloscopes, and a x 10 sensitivity multiplier for voltmeters. Rack mount model only. -*hp*- 460AR, $185.00. -*hp*- 460BR, $225.00.

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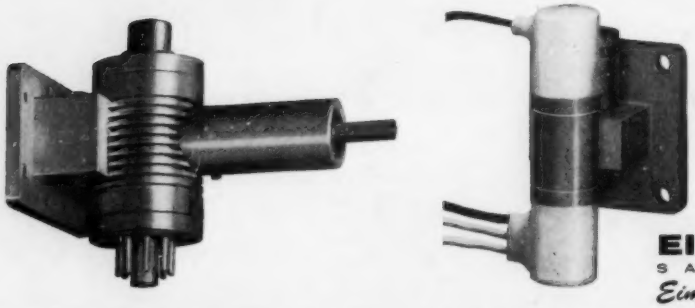

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